HIS MONTH
46 PAGES

"YOUR OWN COMPUTER"—SPECIAL SECTION

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

JUL 1979

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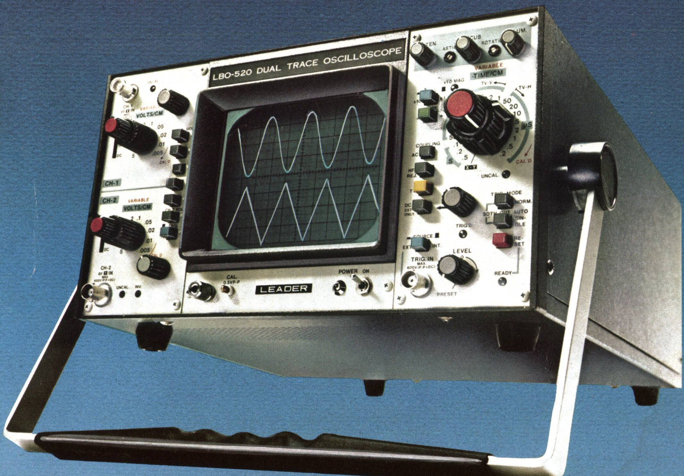
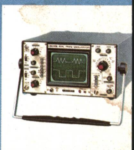


Oscilloscopes







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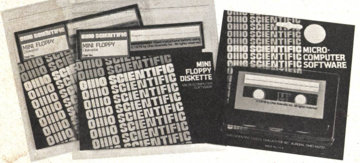
The Challenger 1P Mini-disk system features Ohio Scientific's ultra-fast BASIC-in-ROM, full graphics display capability and a large library of instant loading personal applications software on mini-floppies including programs for entertainment, education, personal finance, small business and now *home control!*



The C1P MF configuration is very powerful. However, to meet your growth needs it can be directly expanded to 32K static RAM and a second floppy by simply plugging these options in. It also suports a printer, modem, real time clock and AC remote interface as well as the OS-65D V3.0 development oriented operating system.

Or Start with the C1P CASSETTE BASED Computer for just $349.

The cassette based Challenger 1P offers the same great features of the mini-disk system including a large software library except it has 4K RAM and conservative program retrieval time. Once familiar with personal computers, you'll be anxious to expand your system to the more powerful C1P MF.

You can move up to mini-disk performance at any time by adding more memory and the disk drive. Contact your local Ohio Scientific dealer or the factory today.

*Both systems require a video monitor, modified TV or RF converter and home television for operation. Ohio Scientific offers the AC-3 combination 12″ black and white TV/monitor for use with either system at $115.00 retail.

All prices, suggested retail.

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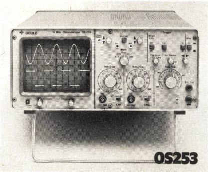
GOULD PROFESSIONAL OSCILLOSCOPES AT PRICES YOU CAN AFFORD.

Whatever your interest in electronics, you know that a quality oscilloscope with a broad range of features and functions can make your work a lot easier. Gould oscilloscopes are built to solve your problems and priced so you can afford the professional equipment you need right now. All are complete, ready for use, including passive probes, input leads and a comprehensive maintenance and operation manual.

The OS245A is a compact, dual trace instrument with a 10MHz bandwidth and 5mV/div sensitivity. It has exceptional trigger performance and a full compliment of facilities for industrial, educational, and field service applications.

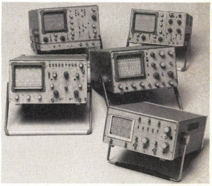


The OS253 is a 12MHz dual-channel scope with all the features of the OS245A plus a larger display area, more sensitivity and channel sum and difference.

The dual trace OS255 weighs only 15 lbs. yet offers features normally found in more expensive instruments such as flexible triggering facilities and 2mV/cm sensitivity across its full 15MHz bandwidth.

The dual beam OS260 gives true representation of two separate signals on the same time frame without beam chopping or alternating. Features include a high brightness CRT operating at 10kV allowing a clear display of all waveforms.

For additional information on this exciting new line of sensibly priced, professional oscilloscopes or for sales locations in your area: call toll free (800) 325-6400 Ext. 77. In Missouri call (800) 342-6600.



Gould also manufactures an additional line of general purpose oscilloscopes for industrial, scientific and laboratory applications.

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MARCH 1979 Vol. 50 No. 3

SPECIAL SECTION

GENERAL ELECTRONICS

BUILD ONE OF THESE

STEREO HI-FI PRO-SOUND

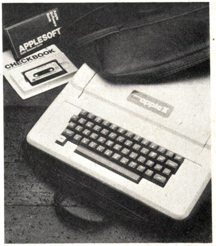
TELEVISION

EQUIPMENT REPORTS

DEPARTMENTS

ON THE COVER

Liquid crystal digital multimeters appear to be the wave of tomorrow. They are inexpensive, highly accurate, offer multiple ranges and are readily available. In this issue we examine the circuitry and IC that have made this possible. For more info see the story starting on page 41.



PERSONAL COMPUTERS are the first two words out of the mouths of electronics activists these days. If you want to learn why they think computers first, our "Your Own Computer" Special Section that starts on page 47 is must reading.

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looking ahead

Videodiscs on sale: Just four years after it was originally promised, the optical videodisc system developed by Philips and MCA went on the market in the last days of 1978. But the marketing was very limited—just a handful of players were offered in three stores in Atlanta so the two companies could come in just under the wire and make good their latest promise of marketing in 1978. During 1979 and 1980, player and disc sales will gradually fan out through the nation, according to the plans.

At the Atlanta debut, the player carried a list price of $695, and a catalog of more than 200 discs listed movies at $9.95 and $15.95, operas and ballet at $20, how-to and educational programs at $5.95 and $9.95. Although a special two-hour disc has been developed for feature films, all except three of the movie titles in the catalog were on one-hour (30-minutes-per-side) discs. The player is being sold under the "Magnavision" label by Philips' subsidiary, Magnavox. The discs are labeled "DiscoVision" and include selections of films from Universal (owned by MCA), Warner Brothers, Paramount, Walt Disney and American Film Theatre.

Although the optical laser system was the first long-playing videodisc system to make it to market (the 10-minute Ted system is being sold in Europe and Japan), it probably won't be the last. RCA's capacitance system is still under development, and though the company had made no specific plans for marketing at presstime, it was aiming at a simple system with players designed to sell for less than $400.

AM stereo progress: The FCC has formally started machinery in motion toward establishing standards for AM stereo. Having received a report of field tests of three systems by the intra-industry National AM Stereo Radio Committee and having judged that two other proposed systems met its technical standards, the Commission merely asked for comments on all five—Belar, Magnavox and Motorola (all tested by NAMSRC), Harris and Kahn. The FCC hopes to expedite the proceeding and there are forecasts that formal rules authorizing AM stereo could be issued as soon as midyear. The FCC also voted to extend its earlier inquiry into quadriphonic FM broadcasting, centering on the question of whether discrete quad broadcasting would inhibit a future reduction in channel separation. Some 2,000 comments have already been filed in the quad proceeding. Matrix four-channel broadcasting is currently permitted on FM, since there is no basic change in the transmitted signal, but discrete broadcasting would require new rules.

Better TV sound: It's really coming, if you can believe the set manufacturers. Reacting to the improved television audio network lines now being supplied by AT&T (see **Radio-Electronics,** December 1978), television set manufacturers are surprisingly in strong agreement that the next major technical step in TV sets is better sound and that the public probably will pay for it.

A survey by the industry newsletter *Television Digest* produced only one strongly negative comment from a set maker, the remainder being positive (although two were noncommittal). Here are some samples: "It is needed. Will be available at minimal increase [in cost]." "Definite need and if priced reasonably consumer will purchase." "Consumer will be looking for more sound-oriented product. Color TV will require improved audio capability along with stereo sound in the near future." "After improved audio is provided by transmitters, all TV makers will improve audio quality in their sets." "Improved audio performance on color TV plus greater availability of pre-recorded materials will represent a very desirable consumer feature and be supportive of the tremendous audio market in the younger age brackets." "High priority for consoles." "Need will grow with projection and video recorder use." "We need improvement, including stereo capability."

Two comments were iffy: "It's a marginal feature." "While there is perhaps a growing interest in improved audio, it remains to be seen how much the consumer is willing to pay for this additional feature." There was only one negative: "Most consumers don't want to pay for improvement."

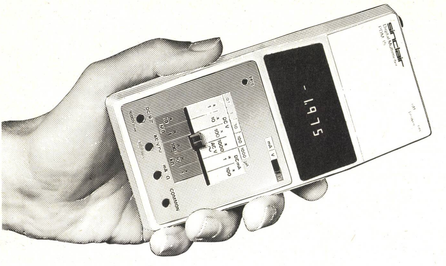
Can it be that we're finally on the way to better TV sound?

VCR's pickup: Some manufacturers had predicted as much as 750,000 sales for home videocassette recorders in 1978. This figure was based on increasing sales toward the end of 1977. But in the opening months of 1978, sales seemed to collapse with fewer than 14,000 units sold to dealers in January, 15,000 in February, rising gradually to 31,000 in June and falling again in July and August. Then in September, the take-off appeared to come, with sales totaling almost 57,000 for the month, more than in the entire first quarter. Some dealers even reported shortages because they were taken by surprise by the pickup in demand. Many credited the introduction of new models, particularly portables and programmables. And all agreed that color cameras were selling unexpectedly well considering that most are priced around the $1,000 mark.

In Europe, meanwhile, Philips announced it was preparing to build a huge new home VCR plant, consolidating all of its production in Vienna. Philips, Grundig and others manufacture a "standard" European VCR system that differs from those in use in the U.S.—in fact, it was the first ½-inch videocassette system to be developed. In its announcement of the new plant, Philips did not state which type of VCR would be built, but it is believed the company has decided on a completely new unit, with a cassette about the size of a VHS cassette, but capable of eight hours' playing time. In another significant videotape development, Britain's Independent Broadcasting Authority has demonstrated the first working digital videotape recorder. Designed for broadcast use, it employs one-inch tape with a writing speed of 2000 ips, achieving an information density of 10^7 bits-per-square-inch. Commercial production for broadcast use was said to be two to four years in the future.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The Sinclair PDM35.
A personal digital MultiMeter for only $59.95



Technical specifications

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ±1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
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Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ±1 count.
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Also provides 5 junction-test ranges.
Dimensions: 6 in. x 3 in. x 1½ in.
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Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet. 30 kV probe.

Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter — quick clear readings, high accuracy and resolution, high input impedance. Yet at $59.95 it costs less than you'd expect to pay for an analog meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicans, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ±1.999.
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The PDM35's 1% of reading compares with 3% of full scale for a comparable analog meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analog meter — and resolution on current is over 1000 times greater.

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The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts — from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

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The Sinclair PDM35 comes to you fully built, tested calibrated and guaranteed. It comes complete with leads and test prods, operating instructions and a carrying wallet. And getting one couldn't be easier. Just fill in the coupon, enclose a cheque/MO for the correct amount (usual 10-day money-back undertaking, of course), and send it to us.

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Credit Card # ______ Exp. Date ______
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new & timely

Manufacturer fights anti-radar detector statutes

Radatron Corporation, a radar detector manufacturer, for many years has been fighting anti-radar-detector legislation at its source—the state legislatures themselves.

By lobbying, testifying, and filing briefs and evidence, Radatron representatives have approached state legislatures and legislators in an all-out campaign that has been remarkably effective in aborting anti-radar detector statutes in several states. They have used two arguments: First, the Communications Act of 1934 "specifically prohibits any government body from restricting or regulating free use of receivers," and pointing out that a radar detector, although it operates at much higher frequencies than a car radio receiver, is still just a receiver and comes under the provisions of the Act. Second, it is almost impossible to write any law against radar detectors that does not at some point violate the driver's legal rights with respect to search, probable cause, due process of law, etc.

So far, Radatron's efforts have succeeded in knocking down anti-radar detector legislation in Wisconsin, Minnesota, Michigan and Louisiana. The "biggie" they are still working on is the state of Virginia, where, although it is not deemed illegal to own a radar detector, it *is* unlawful to operate one. So, if you're caught with one in your car, you must then prove you weren't using it. As one Radatron representative put it, this represents a clear case of being guilty until proved innocent . . . "hardly the American way."

Report outlines and analyzes the "home terminal"

International Resource Development, Inc., has released a 184-page report reviewing the technology, market possibilities and future prospects for the home terminal. Part of the report entitled "Executive Summary" describes attempts at integrated systems made by several countries and discusses the home terminal of the future. Here are some highlights of this report:

Efforts at integrating telephones, home TV sets and radios are already underway in Europe and Japan. In England, the Viewdata system (introduced under the name of *Prestel*) is a two-way TV system in which the home TV screen is used to display data elicited from phone inquiries; a similar system has also been developed in West Germany.

In France, integration has taken a more complex turn with the *Antiope* system. This system combines TV, telephone, tape recording and message delivery—news and "magazine" material are transmitted both over the air during TV "flyback" time, and via phone and tape cassettes sent through the mail. The most ambitious program of all is being developed in Japan—a two-way, fiber-optics integrated TV experiment.

Integration in the U.S. has necessarily been slower because of regulations separating cable, TV, telephone and broadcast network systems. So far, the only integrated service has been limited to two-way TV programs such as that provided by the Warner Cable Company's QUBE system in Columbus, OH.

However, the report goes on to state that integration of telephone, TV, cables, slides, movies and home computers is continuing. An Integrated Video Terminal (IVT) is presently being devised that will combine TV display, phone service, VTR storage, hard-copy printing and home computing. It will reside in the kitchen of the affluent American housewife to help run her home, appliances, bookkeeping, etc. The IVT will be introduced in 1982, and is expected to have an initial cost of around $1400.

The report is published by International Resource Development, Inc., 125 Elm St., New Canaan, CT 06840.

RCA SK CONTEST WINNERS

SK REPLACEMENT SOLID STATE section of RCA's Distributor and Special Products Division recently sponsored a contest in which 19 service dealers and distributor salesmen received VCR's as prizes. Awards were given on the basis of a completing a statement, "I prefer RCA SK's because . . ." Seen here are Larry Prink (center) Westside Radio, TV Service, Eugene, OR; with (from left): Pete Peterson, United Radio store manager; Bob Havercroft, United Radio distributor salesman; Art Cusson, vice president, United Radio, Portland; and Budd Scott, RCA district manager.

"Electronic newspaper" project readied for the public

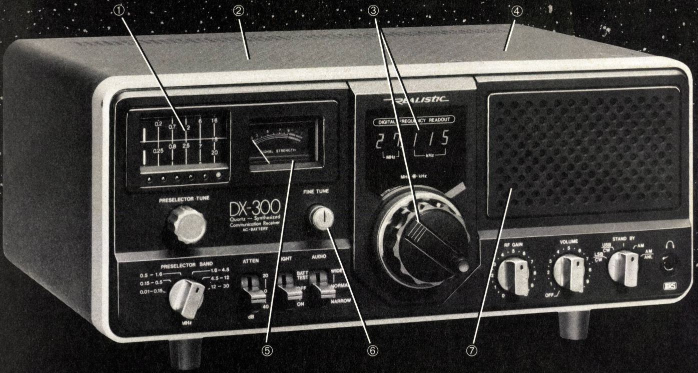
An FM-broadcast-based news and information service called the *Digicast* Project, created and directed by Jim C. Warren, is being readied for possible implementation in 1979. The *Digicast* system uses digital techniques to transmit encoded alphanumeric information via FM transmitter subcarriers.

Digicasting uses only one transmitter to disseminate more news than a conventional newspaper, and it does it faster. Once an editor or reporter decides that a report previously typed into a computer terminal is ready to go, the data is transmitted immediately. It is then up to the consumer to use his specially designed receiver to cull only that information from the flow that he wishes to receive.

The FCC has already adopted a policy legalizing the use of subcarriers for such transmissions. Also, the digital newscast system will not involve a large outlay for special equipment. The receiver modules designed to receive the analog signals and convert them to parallel or serial digital output may bear an initial price tag of $50 or $100, with possible future price reduc-

continued on page 13

NOW! An Affordable Digital LED Readout Receiver that Brings You Exciting Global News, Action and Entertainment, from 10 kHz to 30 MHz Continuous, in 30 Bands!



Tune in the world with the Realistic® DX-300, the general coverage receiver that gives you features never offered at this low price. Enjoy English as well as foreign-language shortwave broadcasts from world capitals and every corner of the globe. Pick up aviation weather and marine SSB. Get WWV time signals and the Voice of America. Hear CB and worldwide Amateur radio conversations and listen to standard AM stations from all across the USA. Accuracy, resetability and ease of tuning are incredible. Just set the dial to the exact frequency of the station you want — 105 international SW stations are listed in the owner's manual alone. For finest reception from any station, the DX-300 has a 3-step RF attenuator, audio bandwidth and RF gain controls, and two antenna inputs. And what versatility: terminals for remote receiver muting, tape recording, screw-on whip antenna for portable use, built-in oscillator and key jack for code practice. U.L. listed, of course. Step up to great listening at a great price. Only 379.95* buys you the world!

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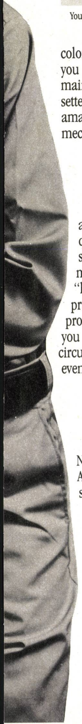
You build color TV, hi-fi, professional instruments.



Now, in addition to learning color TV and audio systems servicing, you get state-of-the-art lessons in maintaining and repairing video cassette recorders, playbacks and the amazing new video disc players, both mechanical and laser-beam types.

Learn at Home in Your Spare Time

And you learn right at home, at your own convenience, without quitting your job or going to night school. NRI "bite-size" lessons make learning easier...NRI "hands-on" training gives you practical bench experience as you progress. You not only get theory, you actually build and test electronic circuits, a complete audio system, even a color TV.

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As part of your training in NRI's Master Course in TV and Audio Servicing, you actually assemble and keep NRI's exclusive, designed-for-learning 25" diagonal color TV. As you build it, you introduce and correct electronic faults, study circuits to gain a better understanding of what they're for and how they interface with others.

Likewise, as part of your audio training, you construct a 4-channel stereo amplifier and tuner, complete with cabinet and speakers. You even assemble professional-grade test instruments, so you know what makes them tick, too. Then you use them in your course, keep them for actual TV and audio servicing work.

NRI Includes the Instruments You Need

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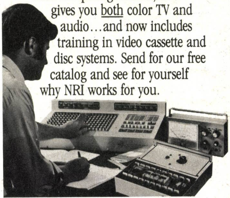
NRI Training Works... Choice of the Pros

More than 60 years and a million students later, NRI is still first choice in home study schools. A national survey of successful TV repairmen shows that more than half have had home study training, and among them, it's NRI 3 to 1 over any other school. (Summary of survey on request.)

That's because you can't beat the training and you can't beat the value! For hundreds of dollars less than competing schools, NRI gives you both color TV and audio...and now includes training in video cassette and disc systems. Send for our free catalog and see for yourself why NRI works for you.



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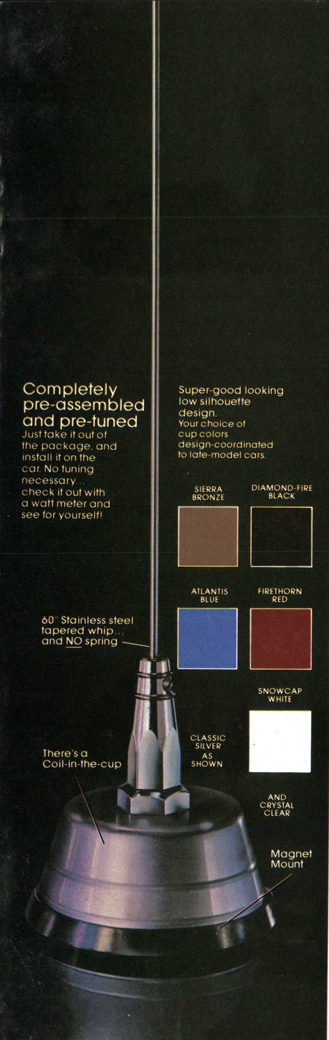

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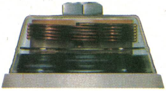

a major advance in antenna technology from the Antenna Pros field tested and field proven by thousands of CBers

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Materials and workmanship of PERSUADER ANTENNAS (Models 13505 & 17605) are guaranteed for a full five years if this antenna is installed by the dealer and a full three years if this antenna is installed by the consumer.
Any part that fails within the guarantee period will be replaced absolutely free provided the registration card has been completely filled out and returned to Antenna Incorporated.

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When you buy this antenna, my reputation...built over 38 years in the antenna business...will be riding on your roof. I'm confident that the Persuader Antennas will persuade you... you've chosen the Best.

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- bandwidth to well over a 40-channel capability

The .125" diameter whip is tapered, so shock is distributed evenly. There's no spring to stretch, break, or bend the whip away from the straightest possible upright position.

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Loading of most low-profile antennas is by a simple printed circuit board that can't be tuned and will eventually burn out. These new Persuader antennas are completely pre-assembled and pre-tuned and feature an actual hand-wound, hand-tuned copper wire loading coil tested with 500 watts, rated at 100 watts continuous. It's even more efficient than our base-loaded coils because it's wound to a larger diameter, with fewer turns.

This unique design also involves fewer mechanical and electrical connectors—fewer resistive contacts between loading coil and cable terminations—less chance for dust, moisture or road gunk to contaminate the contacts.

This concept has been field tested by thousands of CBers in our Model 13503 (shorter whip, plain white cup). Your good buddies will tell you everything we say about it is true.

Available with Trunk-Lip or Magnet Mount

for performance:

- SWR of 1.5:1 or less across all 40 AM and SSB channels.
- Shunt-fed loading coil is DC grounded for quiet performance; bleeds off static from rain, snow, air particles. Performance is virtually identical to body mount antennas.
- Center-roof placement of magnet mount provides your most uniformly omni-directional signal. (Can also mount on trunk lid).
- Unique Antenna Incorporated design provides capacitive coupling. Aluminum plate puts the ground potential right at the mounting surface.

for convenience: Magnet and trunk lip, the two easiest installations! Place the antenna where you want it, plug the cable into the transceiver. No holes to drill. Readily removed for anti-theft protection. Magnet mount supplied with 12' RG-58/U coaxial cable with PL-259 type connector; trunk lip mount with 17' of cable.

for magnet mount adherence: Heavy-duty 2½" magnet in plastic cup with soft rubber gasket. Holds at top highway speeds of 55 mph. (Trunk lip mount recommended for vinyl roof cars.) Since it won't walk, it won't detune! "Oil-can" effect of cup; resting on gasket, provides a larger magnet plane than if the magnet itself were touching the surface—yet there's less weight on the car, less scratch potential.

All magnet mount benefits are standard... not an extra-cost accessory!

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new & timely

continued from page 6

tions as the system catches on.

System design, transmission and format, and receiver plans will be published, thus placing the Project in the public domain. Only specific hardware or software implementations will be proprietary. How many *Digicast* transmitters will be made available overall will depend greatly on the initial venture capital investment. The first unit has already been planned for the San Francisco Bay area, with other areas planned as soon as financing permits.

3M VIDEOCASSETTE

3M COMPANY'S MODEL VK-250 videocassette comes in two-hour and four-hour lengths for the VHS format. This is the second of two home video tape formats for which 3M is supplying cassettes, the first being the Beta product introduced in 1977. The cassettes are to sell for $17.95 and $24.95, respectively.

ISCET returns to normal after year of dissension

The International Society of Certified Electronic Technicians (ISCET) recently took some major actions that will go far towards restoring ISCET to its former integrity and intent. R. A. Villont, CET, president of NESDA, made the announcement, citing past turmoil and dissension that threatened to drive a wedge between both organizations.

To underline the effort not to let ISCET be controlled by the wishes of a few individuals, the following steps were taken: 1) the only legitimate address for ISCET is at 1715 Expo Lane, Indianapolis; 2) no financial obligation would be honored by either NESDA or ISCET for anyone claiming to represent ISCET at any other address; 3) a moratorium was placed on all CET testing until exams are revised and certification administrators re-evaluated; and 4) Ron Crow, Jesse Leach and Leon Howland were relieved of their positions in ISCET.

Mr. Villont also stated that a temporary ISCET chairman would be appointed until members can choose their own chairman, with the assurance that it would be someone that "the average ISCET member can relate to."

Additional RCA SK replacement devices now available

RCA's Distributor and Special Products Division has developed 145 new SK replacements for more than 13,000 solid-state devices. This brings the total SK line to 900 replacements for more than 150,000 industry devices.

Among the new selections are rectifier/damper tubes; new NPN and PNP transistors; SCR/triac combinations; a matched diode set; two hybrid power-amp modules; plus linear and digital components. Cross-reference lists available from RCA distributors will include the new additions along with the entire line of SK solid-state replacements.

Experimental directory help via computer

The day may come very soon when all you have to do to receive directory assistance is just pick up the phone and ask the computer at the other end. Bell Telephone Labs has been (and still is) developing an experimental directory assistance system that can understand most American dialects and even some foreign accents.

The system, still in the research stage, is based on an automatic word recognizer developed earlier by Bell Labs. To recognize a particular spoken word, the computer compares it with a file of stored reference patterns and comes up with the closest match. The earlier system used only a few selected speakers and 100 speech patterns; the present experimental system used a random sampling of 100 American speakers (with no speech impediments). Their voice patterns formed clusters so that each spoken word could be represented by 12 patterns instead of 100. Now every spoken word can be compared with 12 reference patterns for each item in the computer's vocabulary, which consists of the alphabet plus a few digits and commands. If the computer makes a mistake, there's a built-in self-correcting strategy.

The system however has some drawbacks. It cannot understand speech impediments or many foreign accents. It is also necessary to speak slowly, distinctly and with a definite pause between letters. However, a combination of word recognition and self-correcting capabilities do make the system successful about 97 times out of 100. **R-E**

editorial

What's Your Application?

A really interesting data sheet crossed my desk this morning. It describes a 12-segment LED display and an LED driver. The pair are intended for bargraph and level applications. You'll find a reproduction of the data sheet elsewhere in this issue.

Now here's the challenge. I'd like to see our readers come up with some *innovative* applications for these units. That means something unusual, interesting and useful. Send us your ideas along with circuit diagrams. You do not have to build a working unit, but we do request that all letters be typed and double spaced. We'll select the ones we think are best and publish them later this year.

For each application we publish, we'll pay the contributor $10. For the three best applications—the **Radio-Electronics** Editorial Staff will select them and their decision is final—we'll pay $50 each. All entries will, of course, become the property of **Radio-Electronics.**

Now go out and do your thing . . . then fill my mailbox.

Larry Steckler

LARRY STECKLER
Editor

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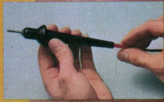

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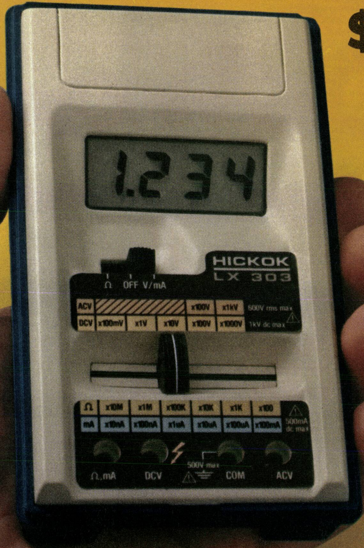

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letters

DIGITAL ON-SCREEN CLOCK

We constructed the clock described in the July 1977 issue of **Radio-Electronics** ("Build This Digital On-Screen TV Clock"). The monitor TV is a Sylvania *model D-12*. We elected to use a 6-digit, 12-hour display. There is one control problem that has proved baffling.

If the RECALL pushbutton is held closed in order to set the time for more than approximately 7 seconds, the display remains on-screen permanently. The timing pot circuit and pot check out OK. Adjusting the pot has no effect on the display, and all the other controls function normally. The clock timing is good, and the display is clear and sharp.

The following display timing parts have been checked and/or changed: IC1, IC2, R18, R13, C9, C8; and the board soldering has been checked out.

We have one small refinement to suggest. The video output transistor Q3 will be operating fairly close to its maximum voltage rating on many tube or hybrid TV's, and some sort of buffer circuit should be used to isolate this high voltage from the collector of Q3.

J. G. ASH
Allentown, PA

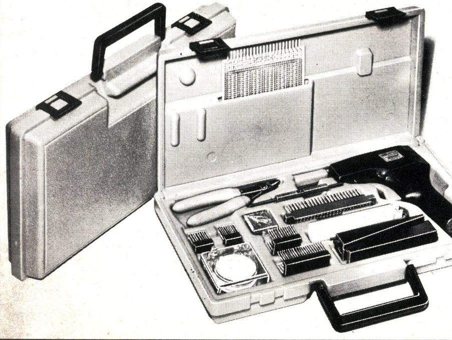
In looking over the circuit, it looks to me as if in the clock's off state, the input of IC2-a is held low by pull-down resistor R13. This makes the IC2-a output high, charging C8. This causes the input to IC2-b to go high for a period determined by the setting of R18—the higher the resistance of R18, the longer it takes for the negative side of C8 to attract enough electrons for the input of IC2-b to become low.

During IC2-b's high input state, its output is low. This does two things: C9 is discharged and IC2-c is gated off, thus turning off the MM5841 external oscillator circuit, and no digits appear on screen. When the input of IC2-b reaches the low state, as electrons travel through R18 to the minus side of C8, the IC2-b output goes high. This accomplishes two things: it tries to charge C9 and it gates IC2-c on, running the oscillator and displaying the digits on the screen. As C9 charges by electrons coming up from ground through R13 to the negative side of IC2-a, after from 4 to 6 seconds, it finally brings the input of IC2-a low again—and we're back where we started. Switch S1 merely bypasses R18, allowing you to make the output of IC2-b high at will.

Bearing this in mind, it appears that whenever the display is on, the IC2-b output is high, and therefore the input is low. It is possible that R18 is set to such a low resistance value that the C8–R18 time constant is within the range of the C9–R13 time constant. Set R18 to a higher value, or add about a 100K resistor between the "top" of the DEFEAT switch between the 12-volt positive input and the input to IC2-b, isolating it with a series 10K resistor. This will force the

continued on page 22

ok wire wrapping center ok



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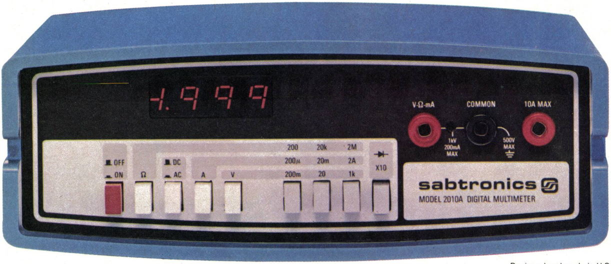

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Resistance: 0.1Ω to 20 MΩ in 6 ranges
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I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

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LETTERS
continued from page 16

output of IC2-b low, killing the display and starting a new C8–R18 timing cycle. You might also have to use a better-quality capacitor for C8. One final suggestion—don't hold switch S1 on for too long a time—set the clock in short cycles.
FRED BLECHMAN

SAGA OF AN AUDIO COMPRESSOR

Len Feldman's article on RG Dynamic's Pro-16 Signal Processor (**Radio-Electronics,** September, 1978) brought tears to my eyes but joy to my heart. His glowing report did much to lighten the burden of guilt I've been carrying ever since the Hollywood 1930's, when John Aalberg, Steve Dunne, Jim Stewart and I (of the RKO-Radio Pictures sound department) developed and put to use the first audio compressor ever.

We dubbed our compressor the "Iron Man" because it kept recorded speech from overshooting the sound track, thus saving many a jumpy mixer from a nervous breakdown. But, most important, it saved the day for RCA, whose recording system competed with Western Electric's (industry name: ERPI) in the fledgling sound movie business.

Before the advent of our compressor, ERPI had us hanging by our thumbs in speech reproduction—walking off with Oscar after Oscar. With their variable *density* recording (H & D curve, built-in half-cycle compression), they had no need to worry about what Fletcher-Munsen already knew: the ear is nonlinear (expansive) at theater levels.

At that time, speech on RCA's variable *area* system jumped and barked; it died right into the noise threshold one moment, or knocked your hat off the next. But ERPI just talked along at any level—smug and smooth as silk.

Of course, our compressor changed all that. Almost overnight, RCA became respectable and then *we* began to walk away with our share of Oscars.

But now comes the sad part. Little did we know that we had created a monster. In those days, our only concern was that theatergoers should understand what our actors were *saying.* Nobody in his right mind thought of using compression on music (just mildly on vocals) because we knew that music, to be vital, needed all the range it could get. Not only was it stupid to compress music and take the life out of it, it was immoral. How naive can you get?

We all know what happened. As soon as the wise guys found out that compression raised the average power and/or modulation (to say nothing of making it possible to employ sound mixers of little talent and no taste), they forced our sweet, innocent compressor into a life of crime, into a device that squeezes into degradation everything that comes its way. Today, even with the most advanced hi-hi equipment, we hear nothing on FM except mangled, choked, squashed, squelched, stifled, clammy, pulpy MUSH!

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CLEM PORTMAN
San Clemente, CA

R-E

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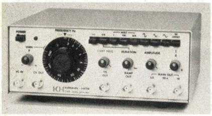
CIRCLE 15 ON FREE INFORMATION CARD

equipment reports

Krohn-Hite Corp. Model 1200 Sweep Generator



CIRCLE 88 ON FREE INFORMATION CARD

ALTHOUGH I'VE KNOWN ABOUT THE KROHN-hite Corporation (Avon Industrial Park, Bodwell Street, Avon, MA 02322) for a while, this is the first time I've worked with one of the company's test instruments. I'm quite impressed with the new *model 1200* sweep generator—a simple name for a very versatile instrument.

The *model 1200* is a complete function generator—producing sine, square and triangle waveforms—as well as a sweep generator. The frequency coverage is from 0.2 Hz to 3.0 MHz in three ranges. The main frequency dial is log-calibrated from 0.2 to 300, and pushbutton multiplier switches marked ×1, ×100 and ×10K select the frequencies. The dial accuracy is ±5% at four settings—0.2, 10, 100 and 300—and ±20% elsewhere. A vernier control with a ±5% frequency range can be used to set precisely on any frequency.

The waveforms are pushbutton-selectable. All the outputs are very low-distortion, with the sinewave output less than 0.5%, the triangle-wave linearity better than 99%, and the squarewave having a risetime and falltime less than 40 ns. Other pushbuttons control sweep selection and sweep multiplication, and a DC OFFSET switch can be used to offset the DC level of any waveform by ±10 volts in open circuit. A separate vernier control for this DC voltage is located just below the DC OFFSET switch.

The bottom of the front panel contains the BNC output jacks. The high and low outputs have a 50-ohm impedance. The high output delivers up to 20 volts P-P, open circuit, and the low output is −20 dB less, or 2.0 volts. The output level is handled by the amplitude control, located just above the outputs.

The output linearity of the *model 1200* is amazing. Place a waveform on an oscilloscope at any level and tune over the full range; the pattern stays put. On sweep, the pattern is just as flat. The manufacturer claims less than 0.1-dB variation from end to end. I believe it; I used a wideband scope.

You can set the *model 1200* to sweep any desired frequency range. Just press the sweep pushbutton. There are two positions on this control for the sweep duration: the first from 1.0 second to 1.0 ms; the sweep time is variable by the DURATION control on the panel. In the sweep multiplier mode or ×1K position, the time is extended from 1.0 second to 1000 seconds.

The setup is simple. Press the sweep button, then adjust the main dial to where you want the sweep to *start.* Hook up a scope to the output. When you observe the frequency is sweeping, set the control marked START FREQ until the frequency *stops* sweeping. The control is now set to exactly the dial frequency. Move the dial marked STOP FREQ to where you want the frequency to stop sweeping, and there you are. To sweep from a low to a high set frequency, turn the dial to a higher frequency. To sweep from high to low, set the dial to a lower frequency than the first. Once the START FREQ control is set, you can sweep from this point to any desired frequency by moving only the main dial. You can cover any frequency band within the range of the instrument. The

continued on page 26

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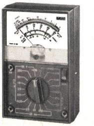

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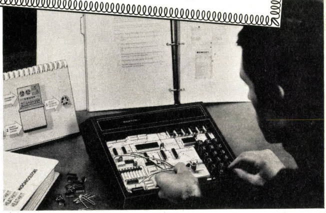

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amplitude of the sweep signal and that of all other signals, is controlled by the amplitude control.

The front panel also contains a TTL output, which is set at the dial frequency. This can drive up to 10-TTL loads with a risetime and falltime of less than 15 ns. This output can be used for triggering, blanking or any other function. On the left is a jack marked VC IN that is used to control the frequency of the oscillator by feeding in a voltage between 0 and ±3. This will give a variation of the generator frequency of 1500:1. Feeding in a sinewave gives a frequency modulation of the output signal around the dial setting.

Another output marked CV OUT is a DC voltage output that is always directly proportional to the generator frequency and ranges from +2.0 mV to +3.0 volts. You can hook up a digital voltmeter here to monitor the frequency or to drive an X–Y plotter, etc.

There's another output marked RAMP to the left of the TTL output. In the sweep positions, this produces a +5.0-volt P-P sawtooth waveform with a frequency that you adjust from 0.001 Hz to 1.0 kHz by moving the duration control. The ramp retrace is less than 75 μs, at a 600-ohm impedance.

While the *model 1200* is far from a simple instrument, its design and construction definitely is. Built on a single large PC board, it contains discrete components and devices that perform many of the functions often found in only one IC. This also impressed me. You should have no trouble at all making repairs if needed, and the instrument carries a year's warranty.

The instruction manual is so plainly written that even I can understand it (that's saying something!). Complete operating and calibration instructions are included, along with a detailed explanation of how every circuit operates.

Heathkit Micoder II Model HD-1984

CIRCLE 50 ON FREE INFORMATION CARD

HEATHKIT'S *MICODER II, MODEL HD-1984* ($34.95), would make a fine addition to a mobile two-meter transceiver setup in your vehicle. It allows you to place a phone call to a local garage or police station, or to call home to explain that you will be late for supper. Another important advantage is that it can be used to obtain directions in a strange city. And, most important, it could be a real lifesaver in an emergency or breakdown.

As claimed, the *model HD-1984 Micoder II* (Heath Company, Benton Harbor, MI 49022) is truly a single evening's project even if you're not entirely at ease using the soldering iron and hand tools required for assembly. There should be little reason for it to take longer unless your evening's free time is limited to an hour or so.

In the *Micoder II,* soldering is important since there is little room for error because the entire unit is contained inside the microphone case.

After assembly, the unit operated as soon as the battery was installed. A cursory check with a small audio amplifier made sure the sounds of the various tones seemed correct, and that there was audio from the microphone.

Next, the unit was connected to the station transceiver for the over-the-air test. With the level control (R103) adjusted to approximately near the center of its range, the proper tones were generated to access the phone-patch of one of the local repeaters. The access tone immediately provided a dial tone in the station receiver. Once accomplished, the rest of the various digits of the telephone number were completed, and the called-party's phone rang perfectly.

The next test was to make sure that the autopatch would "dump" or be disconnected when instructed to do so by the operator. In our local test case (as in many other parts of the country) this is accomplished by dialing the "#" sign. This also worked, the repeater disconnected itself from the phone lines and the call was complete.

All tones in the *Micoder II* are generated by

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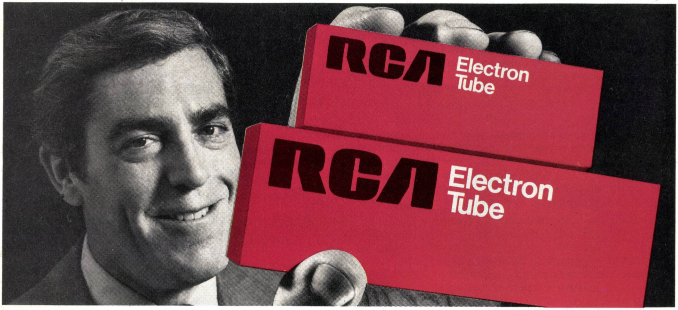

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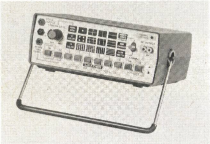
using a 3563.795-kHz crystal connected to a 16-pin IC. Since the unit is crystal-controlled, it is extremely stable and quite free of extreme variations normally encountered by a mobile mike. The crystal control also makes adjusting the tones unnecessary. The project is a one-evening job (as advertised) since there is virtually little to do but to mount the components on the board and then insert the board into the case. **R-E**

Leader Model LCG-397 Color-TV Analyzer-Generator



CIRCLE 89 ON FREE INFORMATION CARD

LEADER INSTRUMENTS CORP. (151 DUPONT Street, Plainview, NY 11803) has produced a new compact battery/AC-powered color-TV analyzer-color bar generator. The *model LCG-397* is quite a small instrument. It measures only 2 inches high, 6 inches wide and 4.5 inches deep, but it can do a great many things. The front panel shows the many patterns it can generate: all 15 of them regular patterns plus a gray-raster, unmodulated video carrier and a subcarrier signal. Six pushbuttons below each vertical row of patterns, and a three-position toggle switch to the right make it easy to set up the pattern you want; including all the standard convergence, crosshatch, dots, V- and H-line patterns. It also generates a single-cross pattern or a single-dot pattern.

Any of these patterns can be injected into the TV set as an RF signal, (on Channel 5 or Channel 6); as a video IF signal (which makes it useful as a tuner substitute), or as a video signal. Both the video IF and RF outputs are 300 ohms, and the video output is 75 ohms. The video IF and RF outputs are 10 mV, and the video output is 1.0 volt P-P sync-negative. The video and RF outputs can be used simultaneously if needed. A scope-trigger signal for vertical (field) or horizontal (line) is also provided, along with a selector switch. This signal is 5 volts P-P. All pushbuttons are of the plainly marked and color-coded push-push variety.

Some unusual and handy tests can be done with the *model LCG-397*. A variable control on the front panel lets you adjust the burst amplitude. Turning this control fully counterclockwise switches it to the CALibrate position for standard burst amplitude. Up to 150% normal burst can be provided, useful for checking the color-sync and the injection-lock type of color oscillator circuits. An added feature is provided: When you turn the burst control down, the color should become *more* saturated in the last few degrees. If it does, this shows that the ACC (*A*utomatic *C*olor *C*ontrol) is working. When the burst is reduced, this circuit thinks that the signal is fading and raises the gain of the bandpass amplifiers.

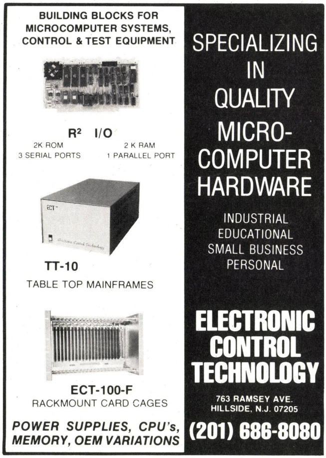
The color-bar patterns include the familiar 10-bar keyed rainbow, a handy three-bar (R,G and B) pattern, and an unkeyed rainbow. The three-bar pattern is handy for quick phasing and demodulation checks, etc. For example, on the B–Y signal, you should see one high pip near the center and only very small pips for the other two—R and G. On the R–Y signal, the red bar should be high, and so forth. This also creates a nice vectorscope pattern.

Leader has prepared a new expanded instruction manual for the *model LCG-397*. It covers not only setup and testing of the instrument, troubleshooting and recalibration, but also goes into great detail on many other tests. These include not only tests of the color circuitry but also the video bandwidth, AGC sensitivity, etc. Many tests for VTR systems are also shown, along with scope patterns and line drawings. This manual is actually a handy short course in color-TV trouble analysis!

All cables and test leads come with the *model LCG-397*. A 300-ohm cable with clips is used for the video IF and RF output, and three color-coded test leads, (also with clips) are used for the video output, ground and the scope-trigger signal. The instrument is powered by four C cells (provided) for portable use. A *model LPS-166A* AC adapter can be used for bench work; it plugs into a socket on the left-hand side of the instrument case. When the adapter is used, the internal batteries are disconnected. Leader recommends you remove the batteries when the instrument is used on

continued on page 36

CIRCLE 49 ON FREE INFORMATION CARD



CIRCLE 67 ON FREE INFORMATION CARD

Selecting a DMM isn't simply a matter of looking for the highest accuracy. It's a more complex process of deciding what features and performance characteristics you need, to do as many different jobs as you're likely to encounter. In short, versatility is just as important as accuracy!

The new 2830 digital multimeter from B&K-PRECISION has all the popular features you'd expect to find on a 3½ digit lab DMM, but it also offers some very uncommon features. Because a DMM may be used under poor lighting conditions or in a very bright environment, the 2830 uses bright, high-efficiency 0.43" high LED digits. The readability of this premium display is unmatched by other readout devices.

The 2830 is also one of the very few DMM's available with a 10 ohms range, capable of .01 ohm resolution. This range offers the user accurate resistance measurement of switch and point contacts, or motor or coil condition. AC and DC current measurement capability extends from 100 nA to 20 amps without the need for external plug-in shunts. For voltage measurement, the 2830 can resolve as little as 100 μV. For maximum versatility in resistance measurement, selectable high-/low-power ohms permits resistance measurement with or without forward biasing semiconductor junctions.

The unit is housed in an attractive rugged cabinet which features a combination tilt stand/handle. Options include a battery pack for field use and a carrying case.

B&K-PRECISION's 2810 DMM offers many of the features of the 2830 but in a more compact package and at a substantially lower price. Features include 100 μV, .01 ohm resolution; high-/low-power ohms; autozeroing; high immunity to RF interference and complete portability.

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continued from page 32

the bench at all times. Using standard C cells, battery life is about five hours; this could be increased using alkaline batteries. A red LED pilot light illuminates when the power is on, and blinks when the batteries are low.

The *model LCG-397* is quite a versatile little instrument, and extremely portable. It fits easily into a caddy to take along for house calls, setup adjustments and in-home troubleshooting. The panel is well marked. In fact, so well marked that we were able to make it work even though I had cleverly managed to leave the manual behind when I took the instrument to the lab!

The *model LCG-397* costs $299.95, and the *model LPS-166A* AC adapter is $7.95. **R-E**

Micro Software Systems Micro-Set I PET Software

CIRCLE 125 ON FREE INFORMATION CARD

USERS OF THE PET ARE AWARE OF SEVERAL shortcomings in its ROM-based BASIC language. One of the most significant is the inability to add one program to another. Micro-Set I is a PET-compatible program that combines the capability of linking programs, deleting lines and renumbering program statements.

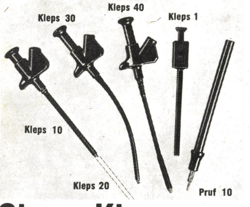
FORTRAN users are familiar with the concept of a subroutine library from which they can draw upon while developing their programs. Rather than having to create mathematical and other subroutines each time they are needed, users can combine or link previously developed routines with their new mainline programs. The PET BASIC and its integral operating system lack this ability. In PET BASIC, the LOAD command resets various pointers and overwrites the old program with the new, wiping out any previously loaded program. This prevents one program from loading a second program while retaining the program statements and the data generated by the first program. Micro-Set I solves this problem by allowing you to generate an ASCII-formated cassette that can be loaded or added later to another program already contained in memory. The program uses some clever methods to achieve this result by digging into the workings of the PET operating system itself.

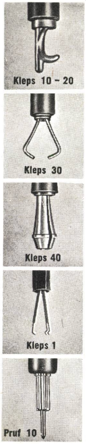
In my sample, unfortunately, this portion of the program did not operate properly. Playing back a Micro-Set I created tape did not affect the already present statements in any way. I took the program apart, drew a couple of flow charts, and uncovered minor inconsistencies in both the portion that creates the tape and the segment that reads it back. I actually tried the program on two different PET's that were purchased about six months apart—with no success. It is possible that some error crept in between the time the program was created and the time it ended up on the tape I received. Incidentally, the tape included three sequential copies of the program which performed identically. No doubt the source of the problem has probably been identified and cleared up by now.

The Micro-Set I command list is as follows: The CREATE TAPE command is used to record a program segment or an entire program onto tape, and the ADD command reads it back and adds it to already existing statements, if any. The DELETE command takes out lines between specified line number limits. The DELETE command is particularly useful in removing the instruction preamble of Micro-Set I after it has been loaded and read by listing. The program INFO command displays the number of lines in the program, the first and last line numbers, and the number of free bytes remaining. Lastly, the RENUMBER command is probably the second really useful function. Even though at the outset you may have to number your program statements by tens to leave spaces in between adjacent lines for editing, it's not unusual for a few of these gaps to be filled during program development. Without a renumber capability, it is impossible to add a line between sequentially numbered statements without extensive messy editing. The RENUMBER command lets you renumber all lines at selected increments and starting at a desired line number. Program jumps and conditional jumps are not automatically updated, however. If a program statement ends with a GOTO, the target address remains unchanged. Micro-Set I does help by displaying a list of the numbers of the lines to be corrected. As the instructions suggest, it is a good idea to copy this list onto paper since it can only be displayed once. This is not necessary if you are fortunate enough to have a printer connected to your PET.

On execution, the first key command letters are displayed in a novel fashion: The first key command letters are displayed in reverse video. Instructions are included on how to add the Micro-Set I routines to your own program.

Micro-Set I is priced at $15 per cassette copy produced by Micro Software Systems, Box 1442, Woodbridge, VA 22193. **R-E**





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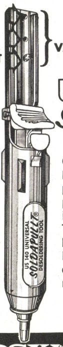

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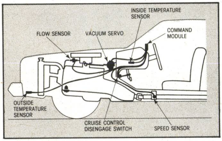

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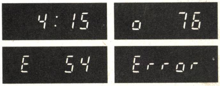

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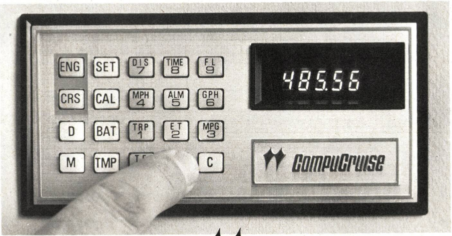

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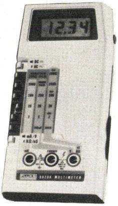

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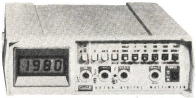

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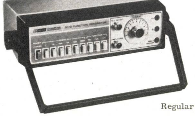

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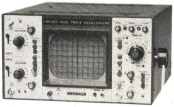

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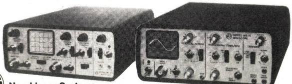

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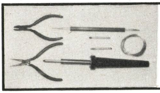

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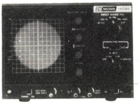

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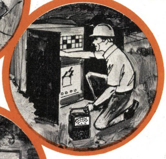

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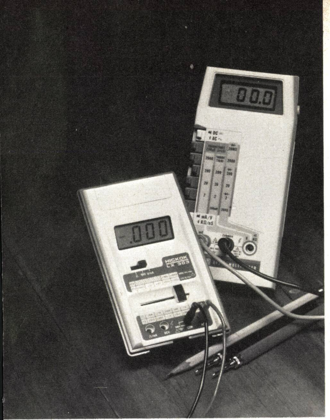


New Trend In DMM's

Digital multimeters are growing smaller and less complex as more on-chip circuitry is developed. Here is a look at the latest in DMM technology.

MARTIN BRADLEY WEINSTEIN

SOMEHOW, THE NEWS THAT SOMETHING that used to be big is getting smaller and smarter isn't as much news as it used to be. The humble multimeter is an excellent case in point. Those of us who remember the early days—or who have seen old-relic instruments in museums—know that in the beginning, there were separate meters for voltage, current and resistance (or, just as often, conductance). In fact, there were often separate meters for separate measurement ranges.

But meters were expensive. So, out of necessity, early experimenters built switchboxes with the resistive networks and patchwork needed to allow one meter to do the work of many.

Over the years, these evolved into the moving-coil multimeters of more recent times. As recently as the 1940's, though, these contraptions were often bigger than the proverbial breadbox; especially when vacuum-tube amplifiers were added to increase the input impedance of these instruments.

Transistors in the 50's and 60's, and IC's in the 60's and 70's, began the shrinking process. But what's made the most difference is the special attention given to the large-scale integration of analog-to-digital (A/D) conversion circuitry in just the last few years.

From A to D with an LSI IC

If the history of IC's could be viewed geographically, we'd see many paths converging on the goal of a monolithic meter-on-a-chip. For one thing, advances in the scale of integration, especially during the 70's, made it possible to include all the digital circuitry for multiple-decade counters, complete with display and logic circuits (but less the actual displays); and also the necessary oscillators, references and A/D converter components (minus a handful of external parts)—all on a single IC. At a manufacturing level, a high level of repeatability is required to let each batch of chips produce enough yield to be economically feasible. In other words, such an IC has to be mass-produced at low cost, because the end product must be price-competitive to survive in the marketplace.

Advances in CMOS technology, and in technological combinations of CMOS with NMOS and PMOS (on the same IC) also played an important role. While well-suited for digital functions, CMOS technology alone is not well-suited for amplifier and buffer applications.

Lasers were first applied to the precision trimming of resistors on the monolithic IC, meaning that high-precision resistor values were becoming, at long last, economically feasible.

And in the laboratory, methods of performing A/D conversion were being compared for suitability in terms of accuracy, economy and ease of realization.

The stage set, the first LSI "meter-on-a-chip" IC's began appearing in 1976 and 1977.

The Intersil ICL7106/7107

Typical of the best of the meter-on-a-chip IC's (even at this writing) is the Intersil pair of 3½-digit single-chip CMOS A/D Converter IC's, ICL7106 and ICL7107. In Intersil's *Application Bulletin A023*, "Low Cost Digital Panel Meter Designs" (May 1977), Intersil's David Fullagar and Michael Dufort include this description:

> "Intersil's 7106 and 7107 are the first IC's to contain *all* the active circuitry for a 3½-digit panel meter on a single chip. The 7106 is designed to interface with a liquid crystal display (LCD) while the 7107 is intended for light-emitting diode (LED) displays. In addition to a precision dual-slope converter, both circuits contain BCD to seven segment decoders, display drivers, a clock and a reference. To build a high performance panel meter (with auto zero and auto polarity features) it is only necessary to add a display, 4 resistors, 4 capacitors, and an input filter if required."

This Application Note presented arithmetic to demonstrate that at May 1977 prices, a 3½-digit LED display panel (single fixed range) meter could be built for $18—*including* labor, assembly and testing. Indeed, Intersil offered simple evaluation kits featuring the new IC for under $30, minus only a 9-volt "transistor" battery that could be wired into working digital voltmeters in about half an hour. Of course, while excellent as projects, these are unprotected single-range meters, and not suitable as full-fledged consumer products.

The impressive data-sheet specifications for the ICL 7106/7107 tell another part of the story:

- Accuracy guaranteed to ±1 count over entire ±2000 counts
- Guaranteed zero reading for 0-volt input

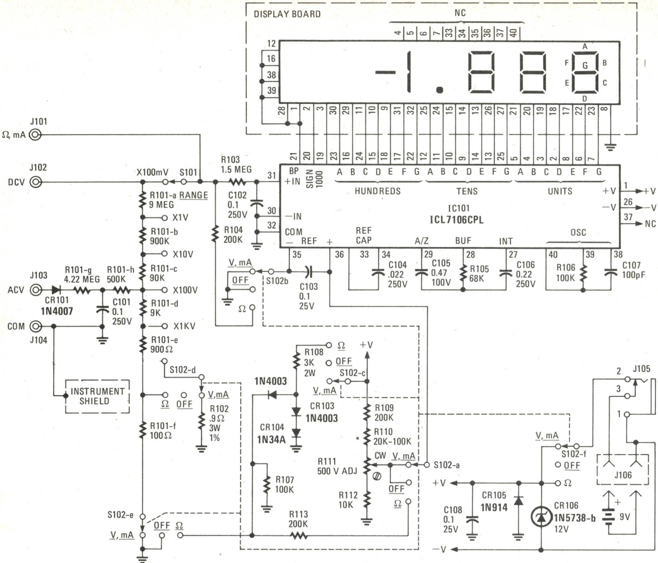


FIG. 1—A COMPACT DMM, the Hickok LX303, based on the Intersil ICL7106 and 3½-digit LCD display. It features auto-zero, auto-polarity selection and automatic over-range indication.

- True polarity at zero count for precise null detection
- Differential input from 200 mV to 2.000 volts full scale

The more detail we study, the more impressive are the electronics Intersil has packed into these 40-pin DIP packages. Let's emphasize, however, that this is only one case. National Semiconductor, RCA, Signetics, Motorola and other manufacturers have also introduced meter-on-a-chip IC's and IC sets (in some cases, two smaller packages can mean a smaller end product than one LSI IC). And all these developments came about to meet the trend toward smaller, cheaper, more power-efficient digital meters.

Low power means LCD displays. But . . . .

For these meter-on-a-chip IC's to work in portable instruments with legible displays and reasonable battery life (with batteries small enough to fit small packages), LCD's were a logical display choice. But liquid-crystal display technology in its youth had many problems that had to be overcome.

Many phenomena plagued early LCD's. For example, extremes of cold, heat and humidity, and of dry heat can permanently blotch an LCD. Exposure to moisture, oxygen and ultraviolet light; imperfections in the glass or the glass seal; impurities in the organic-compound blend used in the displays; dust motes inside the display; imperfect segment contacts; difficulties in mounting and connector arrangements: these are the bugaboos that manufacturers in this fledgling industry had to overcome.

Slowly, as more experience was gained with materials and techniques, the many LCD construction tradeoffs began giving ground. Reliable, survivable LCD's became available for wider (or tailored) drive voltage ranges, temperature ranges and connector options. Lifetime expectancy was on the way up, and prices on the way down.

Now, LCD's are available that are totally moisture-resistant. They are readable in bright sunlight over viewing angles greater than 160°. They offer operating lives of more than 50,000 hours. They are capable of storage from −55°C to +90°C without permanent damage; and of operating from −20°C to +90°C.They are also operable at voltages from 2–60. And they are fast enough to respond to 10 or more updates-per-second.

Not all these extremes can be met by any one LCD. The point is that now inexpensive LCD's make low-cost handheld portable instrumentation practical.

From the possible to the practical

In the real world, technology cannot bring us a finished product overnight. If it could, there would be no manufacturers, only parts buyers, because we could build ourselves what we needed as we needed it. And, as far as LSI IC's are concerned, there is more to the story. For example, let's take a look at the schematic diagram of the Hickok *model LX303* DMM. (See Fig. 1.) This circuitry is based on the ICL7106 and a 3½-digit LCD; but let's take a closer look at what has been added.

Note, for example, that the range switch (S101) selects taps along a voltage divider from R101-a–R101-f. Network

R101 is really a network of six laser-trimmed resistors on a single substrate, providing precision values, close matching and extremely good temperature tracking.

The instrument shield provides a ground plane behind the ICL7106 IC to prevent stray fields from confusing its high-impedence CMOS inputs. This was considered a necessary precaution since the *model LX303* is housed in a plastic case. Notice also R107, R108, R113, CR102, CR103 and CR104, which are only in the circuit with the function switch in the OHMS position. With the values indicated, the metering circuitry is protected even if it is connected to a live voltage source while in the ohmmeter configuration.

For all of its capabilities, the Hickok DMM resides on a remarkably uncluttered PC board, in a small $5\frac{7}{8} \times 3\frac{3}{8} \times 1\frac{3}{4}$-inch package.

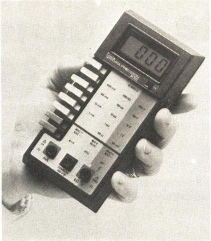
The DMM has come a long way, especially when you consider that with a suggested resale price of under $75, the little *model LX303* outperforms some VTVM's of 20 years ago (and since) that cost much more.

Just a trend?

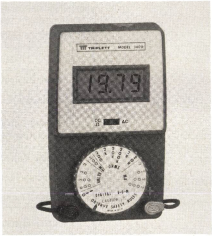
Are we really seeing a trend? It's very possible, especially with so many instrument manufacturers beginning to offer similar products. The following is a listing of what's available in battery-portable, palm-sized, $3\frac{1}{2}$-digit LCD DMM's. All of these instruments feature auto-zero capability, auto-polarity, very low current drain (with typical battery life over 200 hours) and automatic overrange indication.

1. The Data Precision *model 935* at $149 offers 29 ranges of AC or DC voltage plus current and resistance measurements including both high and low-ohms capability.
2. The Fluke *model 8020A*, advertised at $169, features 26 ranges and 7 functions, including conductance plus high- and low-ohms capability.
3. The Triplett *model 3400* at $140 offers 24 ranges and 6 functions, including high- and low-ohms capability.
4. The Hickok *model LX303* costs $74.95 and features 19 ranges.

Also, Table 1 lists the full-scale ranges of these meters.



MODEL 935 DMM by Data Precision.



THE TRIPLETT MODEL 3400 DMM.

Why it's come to this

It's agreed, hand-held DMM's are nifty, but this isn't a good enough reason to bring out a new product. The fact is, there are significant practical advantages to these new small instruments, which are offered at prices that also make them significant values.

The relatively low current drain of this new technology yields one important benefit: a long life on small, inexpensive batteries. As mentioned earlier, these manufacturers all indicate a battery life in excess of 200 hours. You could interpret this as six months of a couple-of-hour-per-day service. Compare this with the 40-hour rating typical of LED meters. And compare the advantages of 9-volt "transistor" versus multiple-size C batteries, even beyond their cost.

One of those advantages is that the end package is smaller and lighter, which means less trouble right away if you drop your meter as much as we all tend to. The smaller package also makes one-hand operation very natural. Many times, you can even hold the meter and one of the probes in the same hand.

The large LCD displays are generally more legible than LED readouts, and specifically so in high ambient-light conditions such as outdoors in direct sunlight. Under low-light conditions, the LCD displays are as legible as any large print; basically, if there's enough light to work by, there's enough to read the display.

The new DMM's are especially easy to calibrate. It takes just three adjustments to calibrate the Fluke *model 8020A*, and only one adjustment for the Hickok *model LX303*.

So these new DMM's are smaller, simpler and smarter. Which, alas, isn't as much news as it used to be. **R-E**

TABLE 1—A comparison of full-scale ranges on "new-trend" DMM's.

Manufacturer	Model	Price	DC Volts	AC Volts	DC mA	AC mA	Ohms
Data Precision	935	$149.00	100.0 mV-1000	100.0 mV-1000	1.000 mA-1000 mA	1.000 mA-1000 mA	100.0-10.00 M
Fluke[1]	8020A	$169.00	199.9 mV-1000	199.9 mV-750 (RMS)	1.999-1.999 A	1.999-1.999 A	199.9-19.99 M
Hickok	LX303	$ 74.95	199.9 mV-1000	199.9-600 (RMS)	19.99 nA-199.9	N/A	199.9-19.99 M
Triplett	3400	$140.00	199.9 mV-600	199.9 mV-600	1.999-1.999 A	1.999-1.999 A	199.9-19.99 M

[1]Note: Also measures conductance (Siemens): 1.99 ms, 199.9 ns

FCC declares RF modulator sales are illegal

The Equipment Authorization branch of the FCC has notified RF modulator manufacturers that selling these devices is illegal (although modulators in kit form are not in violation of FCC rules). Additionally, manufacturers of home computing systems that require modulators for hookup to TV sets will have to redesign their products to incorporate them.

John T. Robinson, chief engineer of the branch, says that in order to be used with TV sets, RF modulators cannot be sold separately from their video source (i.e., the computer). Home computers, on the other hand, *can* be sold without a modulator because technically they don't have to be hooked up to a TV set and thus don't come under FCC jurisdiction. What's been happening is that consumers purchase computers (legally) from one source, the RF modulator (illegally) from another, and then hook up the entire package to a television set.

Since home computers up until now have not had to conform to FCC regulations, the requirement that they incorporate RF devices will definitely make them candidates for FCC inspection procedures and eventual approval or disapproval. So far, the computer industry response to this requirement has been mixed—some manufacturers have already started attaching modulators to their systems and submitting the equipment to the FCC; others, particularly smaller companies, have been slower to react, the fear being that having to wait for FCC approval of their equipment could prove too costly, especially if they have to make major design changes before they can market their equipment. **R-E**

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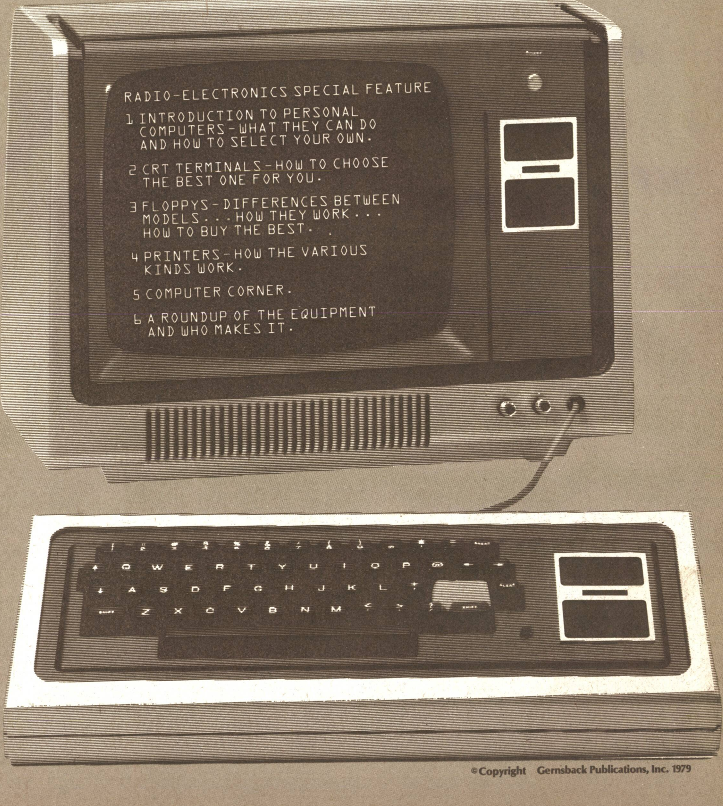

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YOUR OWN Computer

Introduction To

The personal computer is a recent elec-
an active role in our everyday lives. Its appli-
tion. Here is a look at what the personal computer is all about

JEFFREY MAZUR

IF YOU THINK MICROCOMPUTERS ARE JUST A FAD OR you're waiting for them to die out like 4-channel hi-fi, don't hold your breath. They are here to stay and if you plan to keep up to date in electronics you must start learning to deal with computers. Perhaps one of the best ways to do this is to go out and buy one. If you have been thinking about buying a personal computer but can't decide on which one, then the following pages are just for you. In this special section we will investigate personal computers and some of the peripherals available to expand their capabilities. To help you through the confusion of choosing a computer system we will review a few computer basics and outline the factors that should go into making your decision.

The first step towards selecting a computer is simple—STOP! Before you lay down a single dollar on equipment, stop and think carefully about what you are going to do with the computer. Make a list of what you think a computer should do for you and how much you are willing to pay for it. With this in mind, examine the various systems that are available within your budget. When comparing systems, try to normalize their capabilities whenever possible (i.e., don't compare one manufacturer's 4K RAM system to another's 32K RAM system).

The second rule is to use CAUTION when comparing specifications. Unfortunately, there is no standard for rating computers; if you're not careful, you may be misled by the information you receive from manufacturers and dealers. Also beware of claims for fantastic new machines or peripherals that are "not quite available yet." Almost every personal computer manufacturer has had delivery problems on new products (some are still having problems keeping their two-year-old products in stock). Although you will be mainly concerned about the equipment that you are buying, don't forget about the programs (software) that are needed to make your system work. Some computers come complete with much of the operating software already "inside the box," that is, in ROM (*R*ead *O*nly *M*emory); with others you have to buy it separately and load it into the computer. The amount of commercially available applications software may also be important if you don't plan on writing your own.

RADIO SHACK'S TRS-80 microcomputer system.

Finally, when you have decided upon the system that is right for you, go to a reputable computer dealer in your area. Computer sales are seldom a one-shot deal; you will probably be back to buy additional items or may need help in getting your system running. The dealer who sells you a computer knows this and will usually bend over backwards to help you get started. If you know exactly what you want and price is the primary concern, then you can buy from one of the many mail-order firms selling computers. Don't be afraid of losing your money—especially when you can charge it to your credit cards—but be prepared to wait a while if what you want is not in stock. Remember, however, that if you haven't received your order within 30 days, you have the right to ask for your money back. Also remember that the money saved means assistance forfeited.

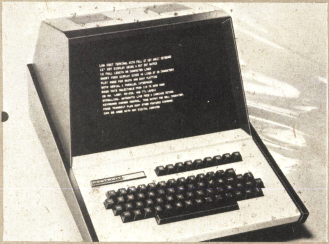
Uses for a computer

As a quick guide, some of the more common uses for personal computers are listed below. With each is a brief description of the factors that will be of most importance when selecting the type of system you'll need.

Educational—One of the reasons most people buy a personal computer is simply to learn about computers. Any computer can be used as a learning tool, but your degree of experience will usually dictate how

Personal Computers

tronic marvel that is capable of taking
cations are often limited only by ones imagina-
and what you need to know to select the system that's best for you.



HEATHKIT H9 CRT terminal.

you plan to communicate with the computer. If you are comfortable programming in binary, hexadecimal, or mnemonics, then you could get by with a small single-board computer. If you want your computer to communicate in more English-like terms and let you know when you make a mistake, then you will require extra hardware and software. Another important factor is the documentation and instruction manuals supplied with the computer. Someone with no experience might want a manual that explains the computer's operation step by step without going into the details of how the computer works. Another person might be more interested in detailed documentation (schematics, software listings, etc.) on the computer he or she selects. Wherever the manufacturer's information is lacking, there are numerous books and magazines that may provide a more suitable description.

Personal recordkeeping, filing, data processing—The key words for these applications are memory and speed. Translated into hardware, that spells a floppy disc. If you also want printed output, or hard copy, then you should also investigate what will be required to connect a printer to the computer. There is software available in this area; it might save you days or weeks from writing your own. For small business use, the software should be tailored to the specific needs of the business.

Home security, menu planning, checkbook balancing, etc.—If your main desire for a computer is to do things like this—*save your money.* Unless you have some extremely complicated system in mind, the above tasks would be better handled with dedicated devices that cost less.

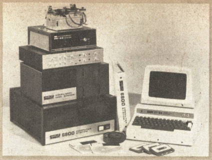
Playing games (nongraphic)—All computers can be programmed to play games (in fact you rarely see a computer demonstration that doesn't include one). Nongraphic games range from the simple question-and-answer variety to pseudographic displays using normal ASCII characters. Since all but the simplest games require some form of alphanumeric input or readout, this means having a terminal of some type. If games are your primary concern, then one of the prepackaged home computers such as the Apple II[1], TRS-80[2], PET[3], Atari or Challenger II[4] would be the least expensive way to get into computing.

Playing games (graphic)—Although many computer hobbyists hate to admit it, personal computers are used to play games more than anything else. One of the reasons is because most of them can display graphic images on a video screen. This makes the computer rival (and sometimes exceed) the most sophisticated TV video games on the market. The inclusion of graphics commands in many versions of BASIC (a high-level programming language that uses English-like commands) has made writing your own game programs even easier. Again, the prepackaged home computers have brought graphics (some in color too!) to a low-cost computing system.

The complete system

A computer system can be roughly divided into four parts as shown in Fig. 1. The first choice you will have to make is the *mainframe* or actual enclosure that the computer will sit in. Choosing a mainframe generally implies selecting a particular bus structure (more on this later) as well as which microprocessor IC is going to be used. Mainframes range in complexity from the simplest one-board computer such as the KIM-1[5], up through the Altair[6]-type "box" with its elaborate front panel, to more conventional turnkey (simple front panel) systems. Prepackaged home computers also qualify as mainframes although they include much more within a single enclosure.

One aspect of the mainframe that deserves special attention is expandability. Since the mainframe is only



SOUTHWEST TECHNICAL 6800 system and options.

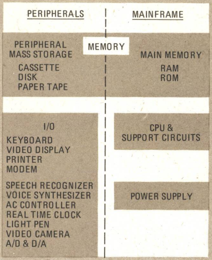


FIG. 1—COMPUTER SYSTEM broken down into components contained within mainframe and peripheral devices.

the beginning of a system, you must allow for the expected additions that you may want in the future. Expandability can be measured by the number of slots available for additional boards, the type and number of external connectors, and by another important factor, power supply capabilities. The power supply is something you want to choose wisely from the beginning, so that you won't have problems later as the system grows. Most large mainframes use standard power supply designs which tend to make them big and heavy. They can easily be compared by the amount of current that they can supply. You can determine what you will need by adding up what all of your components will draw and adding a large safety margin. Don't overlook the possible need for a fan to cool the power supply and all of the various boards. At least one manufacturer (Apple Computer) uses a highly efficient switching power supply in their prepackaged computer system.

Central processing unit

Although your choice of computer may not be based upon what CPU it uses, you should be aware of the capabilities of the particular microprocessor IC that you get. The most important specification of a microprocessor is its data word length. For most of the computers we are discussing here, this will be 8 bits. However, there are many 16-bit CPU's coming out now as well as older 4- and 12-bit devices. As you might guess, a 16-bit machine has about twice the computing power of a similar 8-bit unit. Another important characteristic of a CPU is its addressing capabilities. This includes its total range of addresses (usually 64K) and the various addressing modes supported by its instruction set. Other factors of concern are the clock frequency (or more importantly, the average instruction time) and the CPU's I/O structure. These factors are only given for reference; in reality, almost any CPU can be used for a given task.

If you plan on buying most of your equipment from a single company, then you may not be too concerned with the bus structure or CPU type. Everything will be designed to "plug in and go." However, if you want to take advantage of the enormous amount of hardware and software available from independent suppliers, then you will definitely be concerned with these two factors. As for the former, the present king is the S-100 bus. Any computer designed around this bus can make use of all the various peripherals manufactured to this standard. There are many other bus standards (although it seems like everybody is starting their own lately), and if the peripherals you desire are available for any particular computer, then that's all that matters. As for CPU selection, the same thing applies. Here, the 8080 has reigned but other microprocessors such as the 6800, Z-80, 6502, etc., are finding their own place. When you go to buy software, you will run into a similar problem of compatibility with your CPU. The main point here is that when you go looking at both hardware and software, remember that not every add-on you see will work with every computer. Check out what is available before you decide on your computer.

Memory

A computer would be worthless without some sort of memory to hold a program and data. In particular, we can define *internal memory* which the processor has direct access to, and *external memory*, or mass storage, which the computer must load into its internal memory before it can be used. Internal memory consists of RAM (*R*andom *A*ccess *M*emory) and ROM (*R*ead *O*nly *M*emory). All of the data that the computer manipulates is stored in RAM along with essential information that allows the computer to keep track of what it is doing. Most of the time, the actual program is stored here too.

OHIO SCIENTIFIC Superboard II.

A major question you might ask is: "How much RAM do I need?" There is no simple answer to this question as it depends on the particular computer, program and data requirements that you have. Most computer dealers can help you make this decision. Fortunately, RAM can usually be purchased in blocks of 2, 4, 8, 16 and 32K bytes at a time (a byte is roughly equal to one character). Thus, you can start with a small amount of memory and add more as the need arises.

Of less importance is the type of RAM that you get. It will either be *static* or *dynamic*. Dynamic RAM's are less expensive (per bit), are available in higher density packages (more bits per chip), and consume less power. For these reasons, they are becoming more popular than static RAM's. Their major drawback is that they require periodic "refreshing" or else they lose the information that was stored in them. This means that extra circuitry is usually needed to insure that the memory is refreshed properly. However, microprocessors like the Z-80 are eliminating this problem entirely with "invisible refresh" circuitry already contained within the IC. Static RAM's are still widely used, especially in older machines that were not designed for dynamic memory. Static RAM's do not require any refresh.

All RAM's lose their memory when power is removed (i.e., they are volatile). Therefore, to keep a program permanently in the computer requires some sort of nonvolatile memory. For mass-produced programs such as monitors, BASIC interpreters, etc., a ROM can be used to store the information. A ROM acts just like a RAM whose data has been permanently stored at the time of manufacture. If you wish to store your own programs, PROM's (*P*rogrammable ROM) or EPROM's (*E*rasable PROM) are used. PROM's can be programmed only once—some of them use fuses and are programmed by burning out the appropriate ones. Thus, if you make a mistake or want to change data, they usually have to be thrown out. EPROM's on the other hand are reusable. When you want to reprogram them, they are first erased by exposing the chip to strong ultraviolet light. Newer devices are just coming out that will make nonvolatile storage just as easy to use as RAM's.

ATARI model 800.

When the amount of data exceeds the internal memory capacity, or for permanent storage of programs and data when not in use, we turn to mass storage devices such as magnetic tape, disc, or paper tape. The availability of ordinary cassette recorders has made them a popular choice for mass storage. They are inexpensive, easy to interface, and one cassette can hold millions of bytes. However, they are very slow in transferring data to and from the computer and even slower in finding the correct data on the tape. Some specialized digital cassette systems are available with higher data transfer rates and searching capabilities, but a more popular alternative is the flexible, or floppy, disc drive. This offer is one of the best tradeoffs between price, speed and capacity. Paper tape is used by a small percentage of computer hobbyists; its major advantage is compatibility with larger minicomputer systems. Other devices such as hard discs, bubble memories, etc., are beyond the reach (in terms of cost) of most hobbyists at this time. The increased use of computers, and thus a large amount of memory devices, has made memory technology one of the fastest growing areas in electronics.

Input/output

Getting information to and from the computer is the job of I/O devices. On the input side, a keyboard or terminal is usually used that makes talking to the computer as easy as typing. Other forms of input could come from a modem (telephone linkage), external switches, A/D converter, etc.

The most common form of output from a personal computer is via a video display (either a modified television set or a special CRT terminal). For hard copy, a printer and/or plotter can be added. These are described in greater detail elsewhere in this section.

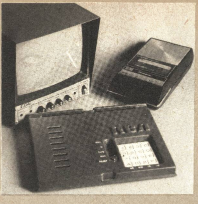
Specialty devices

For special requirements, there is a wealth of peripherals that can be added to your computer. For instance, several manufacturers make speech recognition units and voice synthesizers, making it possible to talk and listen to your computer. Light pens make data entry easy as do digitizers, and even video cameras can be used to give your computer "eyes." For applications requiring precise timing or time-of-day information, there are real-time clocks; and AC controllers allow the computer to turn appliances on and off. For the true hardware enthusiast, blank breadboards are also available to build up your own customized circuits.

Software

So far, we have only discussed the actual equipment that goes into making a computer system. However, this is only half of the story. Without a program (software), the computer would just sit there and do nothing. In general, there are two kinds of software: system and applications. As their names imply, system software consists of programs that allow the computer to function as a complete system; in particular, to make your job of writing application software as easy as possible. Some of the system software that you will want to look for are:

Monitor—A monitor (not to be confused with the television device used for video display) is any



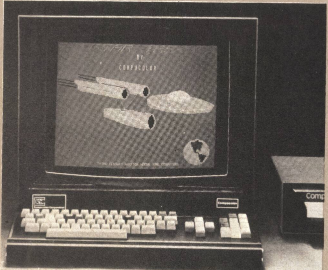
RCA VIP with monitor.

program that allows you to communicate with your computer in terms other than binary 1's and 0's. In most cases, a monitor will allow you to examine, write into, or start execution of a machine language program at any location in memory. Other features such as debugging aids and cassette tape load and store routines may also be included. A monitor is an essential tool when it comes down to seeing exactly what the computer is doing.

Assembler/Editor—Writing programs in machine language is tedious and hard to debug. Changing one instruction in the program can necessitate rewriting much of the rest of the program. With an assembler, the program is written into a text file that can easily be read, documented, altered and debugged. The text file (source code) is then translated into an actual machine program (object code) by the assembler. If there are any errors in the source code, the assembler will identify them, making debugging easier.

I/O, DOS, etc.—These programs are designed for the particular devices to which the computer is connected. They provide the software necessary for transferring data between the computer and the peripheral.

High-Level Languages—To many people, this means BASIC. The purpose of any high-level language is to make programming faster and easier.



COMPUCOLOR SYSTEM has full color graphics.

Languages like BASIC use English-like statements (e.g., LET X=5, A=B+C, etc.) that make learning how to program literally child's play. High-level languages must somehow transform the program into machine language that the computer can understand. This is done with either a compiler or interpreter. A compiler takes a program written in the high-level language and converts the whole program into its equivalent machine code. An interpreter, on the other hand, runs simultaneously with the high-level program interpreting each statement into appropriate machine code one line at a time. Most personal computers with BASIC use an interpreter. Although slower than a compiler, it allows the computer to warn the user immediately when certain mistakes are made.

Remember that unless the system software is in ROM, you will have to load it into the computer from either cassette tape, paper tape, or disc, which will use up some of the RAM that you have. System software is only useful in making the computer easier to program. The actual task that you want the computer to perform must then be programmed into the computer. This is the application software.

Application software

Getting a computer to keep track of payroll, calculate prime numbers, or play chess requires a unique program for that particular application. These may be programs that you write yourself or commercial programs that you can buy and load into your machine.

For doing your own programming, your main concern will be with the languages in which the computer can be programmed. When using assembler/editors and high-level languages, be aware that they are not all equal. There are many versions of the BASIC language for instance; some may be very limited (sometimes called Tiny BASIC) while other versions equal or exceed the original Dartmouth language.

Another concern is with debugging aids that are sometimes included with the language to help you find out why a program doesn't work the way you think it should. Editing, cursor control, graphics and file structures are also important to making programming easier.

Although it may take days, months, or even years to develop a particular program, it takes only minutes to mass-produce copies of it. Because of this, commercial software may be extremely valuable if you don't have the time, skill, or desire to write your own. Prices for personal computing software is relatively inexpensive: usually under $10.00.

Conclusion

Choosing a computer system is not easy. But no matter what computer you get, it will put a new and exciting world of electronics at your fingertips. Buying a computer, however, is only the beginning. As your needs (and budget) grow, you will be interested in adding other peripherals to the system. To help you understand terminals, printers, etc., read on as the next pages describe them in detail. **R-E**

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[1]Apple II is a registered trademark of Apple Computer, Inc.
[2]TRS-80 is a registered trademark of Tandy Corp.
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Printers For Personal Computers

The CRT video display is the most-often-used read-out for personal computers. If you want hard copy, you'll need a printer. Here's how they work.

JEFFREY G. MAZUR

NOT TOO LONG AGO, THE MOST COMMON method of interactive communication with a computer was via a printing terminal (Teletype ASR-33 and Selectric terminals). At first glance, watching one of these machines "type" at 10–15 cps (*C*haracters *P*er *S*econd, or 120–180 words per minute) was rather impressive. However, waiting several seconds for the computer to make a simple reply, or minutes for a small program listing, left much to be desired. At that time, a CRT or video terminal was considered a luxury; its writing speed of 1000 cps or more made it an excellent means of communication. But when you were through working with the computer, you had no written record of what transpired.

Today the situation is quite different. Advances in microelectronics have made the video display much less expensive and almost all personal computers use them as the primary output device. This leaves most hobbyists without any way to generate hard copy. Printers have become the luxury of home computerists, especially when you consider that the price of a good printer may equal or exceed the cost of the computer itself. Whether printed output is your primary goal (generating mailing labels, invoices, tickets, etc.) or strictly a convenience (listing long programs to make them easier to read and debug), the following information should help you choose the right printer for you.

Printer basics

Printers can be classified as either *impact* or *non-impact*, with either complete or matrix character formation. Impact printers operate much like an ordinary typewriter; they rely upon a hard object striking against a ribbon to transfer ink onto the paper.

Non-impact printers use a variety of other technologies to convert electrical signals into readable copy. As for character formation, fully formed characters are printed with a single stroke of an appropriate die. Matrix printing divides the character field into a finite number of cells (dots) in the same way most CRT and video displays do.

These two basic parameters represent many of the tradeoffs that can help you narrow down your choice of printers quite rapidly. For example, while offering good printing speed at low cost, non-impact printers usually require special paper and cannot generate simultaneous multiple copies. So if you want to print mailing labels or multipart forms, you must use an impact printer. For highest quality printing, fully formed characters are desirable; but matrix printers allow special characters and graphics to be printed along with the ordinary text.

Almost all non-impact printers have matrixed characters. Thus we can divide printers into three categories: *fully formed impact, matrix impact* and *matrix non-impact*.

Fully formed impact

This type of printer can range from modified electric typewriters to high-speed drum and band printers. Changing fonts (where possible) calls for replacing the print die. Paper advance can be either friction feed or tractor feed. Furthermore since this is the oldest printer technology, there are many of this type of printer available.

Cheap and dirty

Probably the least expensive approach to making a printer is to add a bank of solenoids to an electric typewriter. The solenoids are positioned over each key and connected to the computer so that they can be actuated at the proper time. Mechanical limitations keep printing speed rather slow (less than 10 cps) and the mechanisms are fairly noisy. But print quality can be very good and the ability to use almost any kind of paper is a real plus for the hobbyist. Some newer models have interchangeable characters on one or two keys that can be used for special applications. If your main desire is to print a large number of letters on your own stationery, this might be an economic solution.

Selectric based printers

Along these same lines, the ball-type Selectric (an IBM trademark) typewriters were made into portable computer terminals. With a top speed of 15 cps, they also double as an excellent typewriter for standard use. Without

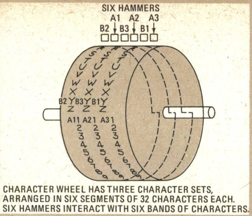


FIG. 1—CYLINDER BASED PRINTING is used in many terminals.

modification, Selectrics require a different electrical code than microcomputers. Additional circuits must be added to make them work with the standard ASCII code. Because of this, most Selectrics can be used for printing only (the keyboard cannot be used as input to the computer). Many suppliers have used or refurbished units for sale at a reasonable price; some include the ASCII conversion. Interchangeable type-balls are available and you can change character fonts easily and quickly.

Teletypes

While on the subject of full-character impact printers, we should mention the Teletype *model 33*'s. These are complete send/receive terminals that were the workhorse of the computer industry not too many years ago. Because there are so many used *model 33*'s available at low cost, many hobbyists have used them as printers. Painfully slow (10 cps) and even more painfully loud (they can make any room sound like a network newsroom), they offer fine print quality and an extra keyboard if you want to use it.

Cylinder drum printers

These printers use a character-studded, rotating cylinder or drum (see Fig. 1). A series of hammers strike the paper against an inked ribbon and the drum to transfer the character onto the paper. The hammers are fired under electromechanical control so they strike the paper at the precise time when the appropriate character on the drum is opposite the hammer. A cylinder printer may contain one to ten complete sets of characters on its face. Thus several characters may be printed before the cylinder must be moved horizontally to its next position.

A drum printer (see Fig. 2) has up to 132 character sets (one for each column that it can print). An entire line is printed at once without any horizontal carriage movement. This type printer consists of a wide range of printers—both in price (from under $400 to over $10,000) and speed [10 cps to 2000 lpm (*L*ines *P*er *M*inute)].

Daisy wheel

These devices get their name from the petal-like construction of their printheads (see Fig 3). A servomechanism controls the position of the character wheel so when the correct character petal has been spun into place,

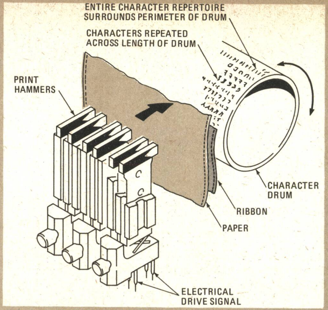


FIG. 2—THE BASIC DRUM IMPACT LINE PRINTER compares the contents of a buffer containing the data to be printed with the position of the desired characters in each print column. At the proper time, the appropriate hammers are activated and the line is printed.

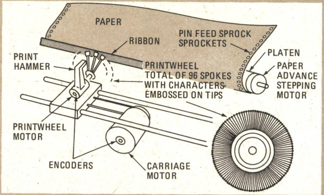


FIG. 3.—A TYPICAL DAISY-WHEEL PRINTER. Many printers use a microprocessor to control the printwheel and the print hammer's impact force.

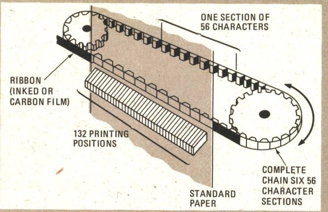


FIG. 4—BAND OR CHAIN PRINTERS are among the fastest units available.

a hammer forces the petal into contact with the ribbon and paper. Their high speed translates into high cost ($2000 +) making daisy-wheel printers a prize that is usually beyond the reach of most hobbyists.

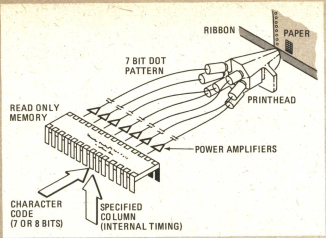


FIG. 5—IN A TYPICAL SERIAL DOT-MATRIX PRINTER MECHANISM like this one from Centronics, a ROM contains the character codes that command the printhead's seven print wires. The ROM's output, fed through power amplifiers, activates solenoids that cause the print wires to impact ribbon and paper.

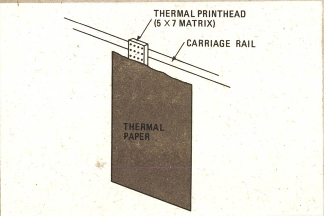


FIG. 6—THE PRINTHEAD OF A THERMAL PRINTER may contain 35 resistive heating elements.

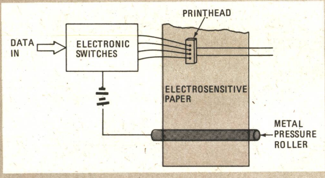


FIG. 7—AN ELECTROSENSITIVE PRINTHEAD creates a spark between the head and the paper. Metal roller completes circuit by contacting paper surface across its full width.

Band printers

At the high end of the impact printer field are the band printers (see Fig. 4). Although currently too expensive for personal computer systems, a brief description of their operation is included. The major difference with band printers is that the character elements are mounted on a continuous band or chain. The band constantly rotates in front of a bank of hammers, one for each column. Again, precise timing is needed to strike the hammers when the appropriate character is in place.

Matrix impact

All printers in this category use a technique similar to that shown in Fig. 5. Because each character is formed by several strokes, more sophisticated electronics are needed to control the printhead. The head itself consists of seven to nine print "wires." Each one is activated separately to print a small dot on the paper. The wires are oriented vertically and the entire printhead moves horizontally along the carriage. After five to seven printing steps, an entire character has been printed and the head moves on to the next column. The most common matrix dimensions are 5×7 and 7×9. Obviously, the greater the number of printing points, the better the resolution and character quality.

Although there is no mechanical way to change character fonts, different characters can be generated (within the limitations of the matrix) by simple software changes. Graphics are easily printed since most computers generate them in dot-matrix form. Friction or tractor-fed paper as well as labels, tickets, etc. pose no problems.

Fairly high speeds can be obtained with this method and at relatively low cost. In general, dot-matrix printers are much quieter too.

Non-impact printers

The increased need for low-cost, ultra-quiet and ultra-fast printers has spawned the growth of several new printer technologies. Fundamentally, these non-impact techniques prohibit multiple form copying and many require special paper. However, where each method excels, it usually makes up for any drawbacks. Because of the need for special paper, friction feed is used, and the lack of fan-fold paper makes long listings hard to handle. On the pro side, these printers are the quietest ones you can buy.

Thermal printers

Thermal printing requires a specially treated paper. This heat-sensitive paper changes color when heated to a temperature of about 200°F. A thermal printhead, therefore, consists of a series of heating elements mounted so that they can create matrixed characters (see Fig. 6). Speed limitations are imposed by the fact that the elements must cool down sufficiently (after being activated) before the printhead can move on to the next position.

To lower cost, many models print "on the fly"; that is, the head is moved at a constant rate from left to right and the elements are activated while the printhead is moving. Although this causes the dots to smear a little, it can actually improve the print quality. Thermal printers boast high reliability, low cost, nearly silent operation and fairly good readability.

Electrosensitive printers

As with thermal printers, electrosensitive printers require special paper and use a matrix printhead to create hard copy. In this case, a dark paper is coated with a thin conductive layer that gives it a shiny metal-like appearance. This paper is passed in front of a printhead that consists of tiny electrodes connected to a switchable voltage source (see Fig. 7). A pressure roller contacts the surface of the paper to complete the circuit. When the electrodes are switched on, a small spark jumps between the electrode and the paper. This spark burns away the

metallized coating at that point leaving the dark paper showing through. Since the gap between the paper and printhead is very small, only about 50 volts are needed to generate a spark.

Most electrosensitive printheads create a column of dots at a time. Moving left to right, they can easily print characters on the fly. An alternative approach is to use one large, stationary printhead, with enough electrodes to cover the complete width of the paper. In this manner, a complete row of dots are created (for all the characters on one line). Several vertical paper motions are needed to complete the line. To print a line at a time, a buffer is needed to store all the characters for that line: therefore, printing cannot start until the entire line has been received. The biggest disadvantage of electrosensitive printers is that the metallized paper makes for poor readability. Making a photocopy of the printed output helps.

Ink-jet printers

The latest advances in non-impact printing have been the ink-jet-type devices. We have included a description of such printers although their cost prohibits use in a personal computer system (see Fig. 8). Basically, ink-jet printers attempt to imitate the operation of a CRT screen. Charged particles of ink are deflected electrostatically to land on the paper in the shape of the desired character.

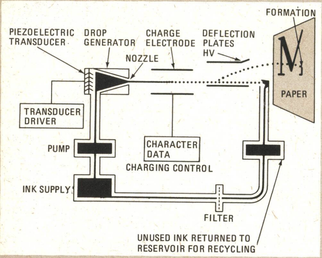


FIG. 8—ONE OF MANY ink-jet printer designs.

Several different schemes have been developed to create the charged ink drops, deflect them and collect the unused ink. This technology promises to greatly increase printing speeds while eliminating all noise except that generated in moving the paper.

Xerographic printers

Another related, and still too expensive, type of printer is the xerographic printer. As you might guess, these devices use an electrostatic/toner design similar to the way photocopy machines work.

Let's wind it up

Other things to look for when buying a printer are paper-feed mechanisms, carriage control and data-handling capabilities. For most applications, friction feed is fine (you can use tractor-feed paper in a friction-feed printer). Tractor feed is only needed when precise alignment of the paper or special forms are used. Above all, be sure that the printer will handle the maximum size paper that you wish to use.

GLOSSARY OF PRINTER TERMS

BAUD RATE—Speed of serial data transmission in bits-per-second. 7 data bits plus a parity, start and stop bit make for 10 bits-per-character. Therefore, the baud rate divided by ten yields characters per second (data rate, not necessarily printing speed).

BI-DIRECTIONAL PRINTING—Printing characters either left to right or right to left. Normally a printhead travels left to right while printing and then returns to the left margin to print the next line. Bi-directional printers will usually check the length of the next line to be printed and then, depending on its current position, either print the next line backwards (right to left) or return to the left margin and print the next line in the normal direction.

CPS—Characters per second. A unit of speed used to quantify printers.

FONT—Character style and size (gothic, script, etc.).

HANDSHAKING—Signals used to coordinate the operation of a peripheral with the computer. A printer might require a signal from the computer to tell it when data is going to be sent and in return might signal the computer when it is ready to receive the data.

HARD COPY—A slang term used to describe any type of written output from the computer.

INSTANTANEOUS PRINTING SPEED—The rate that the printhead can actually print characters. It does not include the time needed to return the carriage to its starting position.

LPM—Lines per minute. Another unit of speed for printers, especially those that print a line at a time.

PARALLEL PRINTER INTERFACE—Connection to the computer whereby the character data is transferred all at one time along seven or eight data lines. Handshaking signals are also used to coordinate printing.

RS-232—A widely used serial interface standard. This standard specifies the voltage levels (bipolar) and connector wiring so that all RS-232 devices will work properly with each other.

SERIAL PRINTER INTERFACE—Connection to the computer whereby all data is transferred over a single pair of wires. Data from the computer is serialized (broken up into individual bits), and synchronization information is added to allow the receiving device to reconstruct the original data.

TELETYPE OR CURRENT LOOP—A serial interface standard which uses a 20 mA (or 60 mA) current to transmit information.

If precise horizontal or vertical tabbing is required, then check out these capabilities of each printer.

Finally, be careful when judging a printer's overall speed. Don't confuse a printer's maximum or instantaneous printing speed with its sustained throughput capabilities. Furthermore, serial printers have a baud rate which may be quite a bit higher than the speed at which it can actually print. If there is any type of input buffer, then the printer can accept a large amount of data in a rapid burst and then print it all out at its own rate.

Not wishing to overlook the obvious, it is imperative that you have the proper interface between the computer and the printer. This will be either a serial current loop or RS-232 standard, or a parallel interface with proper handshaking. Once connected and operating, a printer can be the most valuable addition to your computer. **R-E**

All About Floppys

When you need more storage capability for your personal computer and require faster access speed than a cassette tape recorder, a floppy disc is for you. Here's how to select one.

KARL SAVON
SEMICONDUCTOR EDITOR

ABOUT THE TIME YOU'VE ADDED A SIZABLE CHUNK of memory to your microcomputer system, your tape cassette is working fine with an organized index system, and you spend three-quarters of your waking hours searching tapes and copying from one to another, you're ready for a floppy disc.

Short of a very high capacity hard-disc system, adding a floppy marks the turning point to a new dimension in microcomputing. It is at this juncture that you graduate to professional capabilities. Besides the luxuries of quick filekeeping that are a giant step up in convenience, completely new techniques are opened to you.

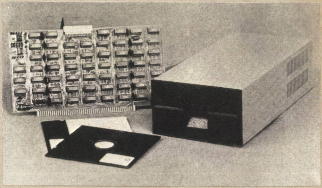
Now Fortran, BASIC and Pascal compilers replace the BASIC interpreter you have learned to live with. The ability to load and overlay versatile operating system programs rapidly into your computer memory really gets you cooking with gas. And for those of you with real-world business and scientific applications, this is the point where you begin solving those extra complicated problems you've been putting aside.

Regardless of specific discipline, most computer users are interested in text editing software; we all have the occasion to write reports and letters. Unfortunately, this software can eat up as much as 75% of your random-access-memory space, and leave room for a mere two pages or less of text.

You may also have a nagging desire to do something substantial in machine language, but find that your sophisticated assembler takes up most of your machine's memory and only lets you assemble a couple of hundred words of code. A floppy ends these kinds of limitations by filling computer memory with only the particular routines needed at any one time. Once the contained function at hand is completed, the next program segment is automatically loaded to attack the next sequential task.

During each processing function, the disc provides convenient addressable storage for numbers or text that don't require the ultra-rapid access of semiconductor memory, but must be close at hand. Business applications use the disc to store a repertoire of bookkeeping programs and provides quick retrieval for statistical processing of the thousands of pieces of information that have been collected.

A floppy disc is similar in appearance to a phonograph record, but is more flexible, and in most cases is physically deformed as the magnetic head and pressure pad contact the disc surface. There are some notable floating head exceptions that, despite superior media longevity, are not going to fit into your long-term compatibility plans, not to say anything about cost. The disc spins about 360 rpm and stores data on one or both of its surfaces.



MECA MODEL DELTA 1 floppy disc system

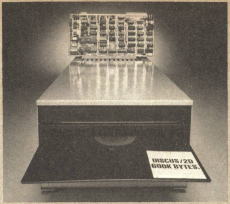
A disc is a random-access device much like program memory. In contrast to the sequential nature of tape, you can locate anything stored on a disc much faster than on a tape and without rewinding. The magnetic head is positioned over circular tracks with a servo-controlled stepper, or voice-coil head positioner. The magnetic disc surface has a life expectancy of 10^6 loaded passes.

Be sure that the disc system has an automatic head lifter that separates the head from the disc after some predetermined time following a read or write operation. Whenever the disc spins, even with the head lifted, there is a certain amount of unavoidable wear caused by the friction between the disc and its protective jacket. The access time to get from one track to another, added to the settling time to load the head in contact with the disc, varies between 10 and 100 milliseconds from product to product. The faster the better.

What size disc for you?

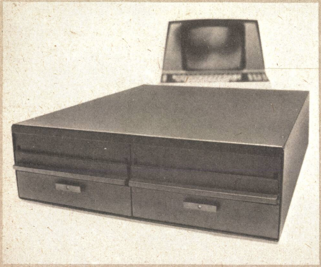
One of the first decisions is to select disc size. Fortunately there are only two: the full size 8-inch disc, and the 5¼-inch minidisc. Obviously the larger disc holds more information than the smaller one and has the higher price tag. The 8-inch disc holds some 3.2 megabits of unformatted data. That is, there are somewhat over three million binary storage locations. However, to keep everything in its proper place requires an indexing and data identification system. Cyclic redundancy codes must be set up to help you know when the data is reliable.

In the widely adopted IBM format, identifiers are written in front of each record; and records are separated by



DISCUS 2D floppy system

gaps. Error checking is done by reading the data back just after it is written (usually on the next disc revolution). Soft error specifications are between 1 in 10^8 to 10^9 bits, indicating how often a bit is read incorrectly. Soft errors are caused by noise and are overcome by simply repeating the read operation. Hard errors, on the other hand, represent permanent defects on the disc and typically occur once in 10^{11} to 10^{12} bits. Seek errors occur about once every 10^6 accesses and are the times when the head undershoots or overshoots the correct track and must go back to track 0 and try again.



AN 8-INCH FLOPPY DISC system by Smoke Signal Broadcasting

By the time you're finished, the formatted disc capacity has been pared down to 1.9 megabits. When this is divided by 8 bits-per-word, you have some 250,000 words of storage. Transfer rates for the full size disc are about 250,000 bits-per-second. The standard format consists of 77 concentric tracks, each with 26 sectors, and each sector containing 128 bytes. Some discs use hard sectoring where a series of physical holes identify sectors so that less disc overhead is used. If you foresee the need to be compatible with hard sectored formats, make sure the system is expandable to control hard sectored drives.

The 5¼-inch floppy

The 5¼-inch disc works out to about one-quarter the 8-inch capacity; about 72K formatted bytes, with a 125 kilobit-per-second transfer rate. A 5¼-inch drive costs roughly 60% the price of an 8-inch drive, but before you make your size decision let's make one more observation. In the course of using your system you will discover that two disc drives add up to more than just doubled storage capacity. Once you have a single disc drive set up with your favorite programs, operating system, or data, and you finally sit down a moment to think, you will find yourself beginning to shake. On that one record, you figure out you've invested about three months of your life. You realize that it is vulnerable. What should happen if that disc gives you an unrecoverable load error, or one of the kids tries to play it on his phonograph?

Yes, it would be nice to have a copy stowed away. Copying, by loading one program at a time and then saving it on another disc is a long, tedious, annoying procedure at best. Two discs give the invaluable flexibility of copying one automatically to the other, using utility copy programs in a completely painless manner. Running

THE DYNABYTE DB8/4 disc-drive system

system programs such as assemblers and compilers, two discs have the advantage of being able to input data from one disc and storing output on the other. One disc can hold the operating system elements that are called up as required, and the other stores the text, data or other outputs.

A dual disc system that can load both heads at the same time will carry out copy operations with even higher efficiency. Another alternative to consider is to use a single disc, but do archival storage on tape. The tape writing and disc regeneration procedures will be slower than with two discs but still manageable. So when you list the system alternatives be sure to consider multiple disc expansion.

If the cost of a dual-drive 8-inch floppy is just too much of an investment, see if the capacity of a dual minifloppy is sufficient. There are, of course, exceptional situations where a restricted application requires only large storage, and a single-drive is justified.

Several disc systems use double density recording techniques. By using improved, modified FM (MFM) or group code recording (GCR) encoding methods, they pack twice the number of bits on the same size disc. Double density recording methods make room for additional information by eliminating the clock signal. The clock, though, can be recovered through clever decoding algorithms. There seems to be a general feeling that the present reliability is not quite up to what it is for single-density recording, but that should soon be at an equal level.

Check the reliability figure comparisons between single and double density recording, when available, and don't be fooled by reliability claims that cover just the electronics. A couple of clever drives have discovered that the disc has two sides and access twice normal capacity with two heads. There are reports, though, of disc damage due to the loss of the cushioning effects of the single head and pad combination. Combining double density and double side recording gives the minifloppy the same capacity as the full size floppy disc (with slower throughput).

MODEL EAS-EDDS from Electro Analytical Systems

Interfacing to your computer

The disc must get connected to your computer. Many varieties and degrees of interfacing are available. Unless you're a glutton for punishment, don't go out and purchase a basic disc drive mechanism hoping to save a lot of cash by doing your own interfacing. Several reasonably priced systems are on the market that have been designed by experts, and have been debugged for many, many hours. You would go a long way to duplicate their performance. Many include complete hardware and software packages. The disc controller carries out the head positioning, head loading, sector identification and motor control functions.

Relatively new floppy disc controller IC's have greatly reduced controller complexity and price. They eliminate many IC packages and result in a more reliable, less densely packed controller board.

Usually some form of read-only-memory bootstrap is used to get things started. Until some minimum of software is loaded into the computer, it and the disc will not be able to communicate. Once the basic link has been established, more efficient loaders and operating system program modules can be transferred from disc to computer memory. Many systems require a large chunk of user memory, which may still work out to be cost-effective.

Some elemental systems require various machine language sequences to control disc operations and may require substantial machine language programming effort on the user's part. This is not for most of you. You have the option of obtaining operating system software from the disc drive manufacturer or from some other source. Generally, the first choice is more desirable, since it offers a higher confidence level that the bugs have been ironed out or that you will be kept informed of corrective patches as they are developed.

Most operating systems use a monitor that is transferred into memory. The monitor responds to keyboard commands by either carrying out the simpler tasks itself or calling a more complex executing operating system module from the disc. Know the computer memory requirements to support the program modules. Twenty-four kilobytes is not unusual to support disc BASIC, for example.

The operating system should include utilities for memory and program listings. Look for an initialization procedure that not only formats a blank disc, but allows you to later reconfigure the system when other peripherals or additional discs are added. Usually subtle software changes have to be made in the operating system, and it is highly desirable to be able to go through a documented procedure without having to scrap the whole thing. It is very important to recognize that the floppy disc software not only controls the disc itself, but the *entire microcomputer system*. In effect, the floppy disc operating system becomes the controller for all other peripherals.

All operating systems should include basic delete, rename, directory and copy programs to perform the rudimentary day-to-day jobs you're buying the disc for in the first place. Look for some version of a chain command that lets one program module call in a second from the disc, giving large virtual memory appearance. Operating systems should include methods for keeping track of hard disc errors. A defective sector table is conventionally composed to flag those places on the disc found to be unusable.

Watch the mechanics of the interface. Several disc varieties include single or double board controllers that plug into standard S-100 motherboard slots. Others include the controller as part of the disc system and have a cable and connector that runs over to the computer. Be sure you have included the costs of all the interface components in your estimates. It is not unusual for the interface electronics to cost as much or more than the disc drive itself.

Power supplies are another consideration. Some units may require 30 watts, and some 300 watts, depending on the number of drives and the extent and efficiency of the system. Power supplies are often not included as a part of the disc system and represent additional cost and space.

A couple of floppy systems operate optionally or exclusively through serial RS232C ports. This is OK for some basic data storage requirements where the disc is replacing an outdated paper tape system, but it is too slow for general versatility. After all, the system should give its full performance potential, not just replace paper or magnetic tape.

At the outset try to access your ultimate goals. Does the system you've selected have the capability to expand to 4 or 8 drives for the sophisticated application you have in mind for the future? Exactly what is required to carry out that expansion? Try to combine the technical specifications with the perspectives of experienced floppy users. Experienced users are in a position to quickly point out the weaknesses and advantages of specific systems, which are not mentioned in the data sheets. Talk it over with several members of a local computer club or a computer user at a nearby high school or college. Your choice will rapidly narrow to the two or three systems that are being universally accepted due to their relative freedom from problems, and you will enjoy an exciting new dimension of an already mind-boggling activity. R-E

CRT Terminals—

To many newcomers to the field of more experienced users, the CRT terminal discusses the CRT terminal and

KARL SAVON

THE INNER SECRETS OF YOUR MICROCOMPUTER SYSTEM are best viewed through the eyes of a CRT terminal. Input commands, output listings, and program writing and execution are all supervised from the keyboard and displayed on the screen. The terminal's ease of operation and reliability directly affect the overall utility of the complete computer system.

Theoretically, a computer system can be controlled completely with a series of simple switches and some LED indicators. In fact, that is exactly the way many early microcomputers were equipped. But you can't get much useful work done with such primitive handles. To address these shortcomings, the CRT terminal has emerged as the system focal point, with input facility at a conversational rate and with output capability essentially limited by the calculative speed of the particular program being executed.

Your present computer input/output device may be an intermediate combination of a simple keyboard and an LED alphanumeric display. You're now ready for a higher level of communication. Or you may be in the process of expanding an elementary learning system, having just added memory and maybe a BASIC interpreter in ROM, and are ready for better computer interaction. In either case, the display of a full page of information in response to typed commands announces your arrival out of phase-one and hopefully into the productive application phase.

The transmitter keyboard unit and the display CRT receiver are entirely separate entities except for common power supplies. You can actually purchase the two elements separately. The display looks peripherally like a TV receiver, but don't assume it will have similar performance.

Screen brightness must be high enough for comfortable viewing under prevalent ambient light conditions. Ideally, brightness and contrast should be user adjustable. Color is available where graphic complexity warrants it to emphasize significant display features, or simply for its attraction in personal computer applications. Examine the screen for linearity and resolution. Even though the CRT's tend to use standard television deflection methods and have scan rates close to NTSC standards, many suffer from linearity deficiencies when compared with your living room instrument. Resolution may be greater than most TV receivers, but large screen sizes are generally unjustified except for group demonstrations.

The most common screens measure 12 inches diagonally and use a P4 white phosphor. Many can be optionally equipped with P31 green. If possible, as with any expensive product, examine the terminal through a hands-on trial, preferably connected to a computer similar to your own.

Characters are most often displayed as dot matrices. A character decoder-generator uses a read-only-memory to convert ASCII or other codes into their equivalent dot matrix patterns. Even normally nonprinting character codes are displayed on some terminals. The dot matrix is usually 5 × 7 dots dedicated to the character itself with at least one additional horizontal and one vertical line separating characters and lines. Other common formats are 7 × 10 and 9 × 9 matrices. Larger matrix formats have room for standard lower-case characters. Others simply use smaller versions of the format or font used for capitals as pseudo lower case.

Deluxe character generators give more detail and fancier letters and have correspondingly larger matrix sizes. They are available in languages other than English, including French, German, Swedish and Japanese. If you are interested in APL (*A Programmers Language*) programming, search out the terminals with the nonstandard APL characters. There may be 64, 96 or 128 characters in the sets, and terminals with graphic capability typically include 256 characters. Screen format consists of 1000 to 2000 characters arranged in lines that may be 40, 64, 72 or 80 characters long.

Some terminals let you define your own characters on a dot by dot basis, or by groups of dots. Graphics users must know the number of controllable dots along both axes. And if your graphic applications are serious and extensive, you may want to consider vector graphic capability which lets you do things like define end points and the terminal fills in the rest. Business users will want to explore the terminals that are specifically designed to simulate business forms on the screen.

Automatic right-margin wraparound is a fairly standard feature that permits multiple line entry before a keyed carriage return terminator signals the true end of the line. This feature is very important when a relatively

Selecting The Right One

personal computers as well as many
is the most visible component. This article
tells what to look for when selecting one for your system.

wide column printer is used to create hard copy. For example, using an 80-column printer, it is necessary to accept two 40-character CRT generated lines without an embedded carriage return and line feed. In other words, a carriage-return line feed combination is automatically generated for the CRT screen but is not transmitted to the printer interface.

Terminal types

There are three basic terminal classifications: Dumb, smart and intelligent. Regardless of "intelligence" level, any of the three types may well be microprocessor controlled. Integrated circuit video display controllers are also helping cut component counts roughly in half.

The dumb terminal is the least expensive, little more than a keyboard and CRT display, appropriately called a glass teletype. The glass teletype is much, much quieter than the venerable device it replaces, and for the 80% of the time that hard copy is not needed, the quiet is a welcome relief. Fan cooling may be used to increase reliability, but make sure it is quiet. If the fan noise level is going to be disturbing in a relatively quiet room, you had better select a fanless terminal.

The smart terminal has self-contained editing hardware and firmware usually implemented through a movable cursor. The cursor may take the form of a blinking square or blinking or nonblinking underline. Editing techniques include inserting, writing over and deleting on-screen information. Editing results are displayed immediately with little chance for misinterpretation. System applications that do not tie up the CPU processor during editing sessions offer the alternative of using the computer processor as a controller to make a dumb terminal look smart.

The intelligent terminal approaches a complete microcomputer in function. In addition to the editing facility of the smart terminal, it is programmable. Intelligent terminals may include built-in peripherals such as floppy discs and magnetic-tape-cassette drives. The two higher terminal classes may have addressable cursors. Designated control character codes give left, right, up, down, home and clear functions as well as direct addressing.

Data is normally entered starting with a clear screen at the top left and fills the screen downward, line by line. When the bottom screen perimeter is reached, the entire page scrolls upward, eliminating the top line leaving room for a new entry at the bottom. Page-mode is sometimes supplied as a switch-selectable feature. Page-mode fills the screen from top to bottom but when the page is filled, the screen is cleared and entry begins anew at the top. Memory options for off-screen storage are nearly essential on a CRT terminal using page mode, which may explain its relative unpopularity.

About keyboards

The keyboard has 50 or more keys and may include a separate numeric keypad for voluminous arithmetic input. Touch typists will find formats that put numbers only on the separate keypad very annoying. In fact, many keyboard layouts which may appear similar to a typewriter intermix graphic symbols as upper-case characters and define normal upper-case typewriter symbols as lower case. These arrangements will give the experienced typist headaches as he switches between typewriter and terminal.

Some keyboards have an upper/lower-case switch to generate letters, graphics and control characters from a limited number of keys. Nearly standard typewriter keyboards can be found though. They have a capital lock key and a separate (5th) row of keys for control characters.

Keyboard layout may resemble a typewriter's, but, for example (although unusual), may be simplified by arranging keys in vertical columns. Keyswitch feel varies considerably and you certainly want the switch contacts to be reliable. The quality of the key switches themselves are vital. Some of the most sophisticated keyboards include quadruple redundant reed switches that even operate perfectly if one or more of the contacts become noisy or fail. Highly reliable noncontacting keyswitches use capacitive, photoelectric or Hall-effect sensing mechanisms. The keyboard should incorporate 2-key or n-key rollover so data can be entered at high rates with a minimum of errors. Several keytops are often removable for special application customizing.

Important extra features

Reverse video is a common feature for emphasizing characters or groups of characters as well as extending graphic effects. Sophisticated terminals permit protection of designated screen areas from accidental erasure and

can selectively blink several characters simultaneously. A rare feature is the ability to emphasize text by doubling the character width. Character dimming or brightness modulation is another fairly common feature.

There are a couple of seemingly unimportant features that are of interest to specific groups of users. For example, when the cursor approaches the end of the line an audio tone may sound, analogous to the typewriter bell. Tone trigger position is occasionally programmable. These terminals invariably can trigger the tone from a computer instruction, normally the ASCII 7 print command. Several or all keys may be auto repeating. After a prescribed time out following key closure, the keyboard system generates a fixed rate character repetition.

Once in a while problems are caused by the convention of automatic line feed following carriage return. You normally expect the CRT display to increment or line feed once each time the return key is hit in typewriter fashion. However, some tabbing operations require carriage returns without line feeds. If the computer automatically sends out carriage-return line-feed combinations for either carriage return or line feed, the display format will alternate blank lines with printout. The terminal should include a switch or jumper option to disable automatic line feeds. But you may have to add this feature yourself; it isn't difficult.

Interface connections

The terminal may interface to the computer through serial or parallel connections. Serial formats are conventionally RS232C asynchronous sequences of start, data, parity and stop bits. Word format may be DIP switch or jumper selectable since universal asynchronous receiver transmitter IC's are easily programmed by voltage levels on specific terminals. Even or odd parity and the number of stop bits are selected to be compatible with 9, 10 or 11-bit computer formats. The standard RS232C interface uses bipolar signal levels but the same basic format is used in TTL-compatible single polarity systems. Another widely used serial interface is teletype-compatible where series current loops of 20 or 60 milliamps are established.

Serial communications between the computer and terminal is half or full duplex. In half duplex, the computer and CRT receive data at nonoverlapping intervals. While typing the keyboard signal is routed to both the CRT and the computer so that the input is displayed. If the connection between terminal and computer were broken, the CRT would still respond, and it would only be later due to lack of computer response that you would know something is wrong. In full duplex, the two directional paths can operate at the same time. When the computer receives a character from the keyboard it responds by echoing the same character which is then displayed by the CRT. Serial transmission rates are between 75 and 19,200 bits per second.

Parallel interfaces can handle much higher data rates and are usually carried out with eight parallel data lines and a couple of handshaking leads. Parallel interfacing is a synchronous operation and signals are generated to tell when data has been accepted, when the receiver is busy and cannot accept data, and when data is valid. Parallel outputs are often three state; they have an open state so several terminals or other peripherals can operate in parallel on the same data lines.

Terminals can interface directly to the *IEEE Bus* when properly equipped or through adapters. The *IEEE Bus* is a parallel 8-bit bus that can send device selection address information over the same leads. Crystal-controlled baud-rate generators offer the best tolerance to variable environmental conditions. Some serial terminal interfaces have separate transmit and receive baud-rate generators that allow the two paths to be split or operate at different data transfer rates.

The *7-bit American Standard Code for Information Interchange* (ASCII) is the nearly universal standard now in use. Five-level Baudot code is just about extinct for CRT computer terminal applications. Several graphics terminals expand ASCII to an 8-bit code that doubles the character-set boundaries to 256. IBM EBDIC format is an 8-bit encoding format offered by a number of manufacturers.

Modems and data transmission

Modem options allow terminals to be connected via the phone lines to remote computers or other terminals. Modems use frequency and phase-modulation techniques that when combined with error detection and correction techniques give reliable data transfers. While this is the method overwhelmingly used by time-sharing systems, more and more private computer users are turning to modems to access their machines when away from home. Acoustic couplers provide nonelectrical phone-line connections at limited data transmission rates. Computer information exchange networks are becoming common where club members access a disc-based computer system over phone lines.

Data transmitted from the terminal to the computer is sent on a character-by-character basis as in the glass teletype or may be sent a line or page at a time. Larger block transmission gives the operator the opportunity to correct errors before digestion by the computer.

CRT terminals often have parallel or serial hard-copy adapter interfaces that directly drive printers to create hard copy of selected pages. This interface is similar to the computer interface except simpler, being one way.

If you plan to do your own maintenance ask about serviceability. Are sockets used? Do the printed circuit boards slide out for easy access? Is there built-in diagnostic software? And most important of all be sure that the terminal you select will be capable of easily handling the tasks you intend to set before your computer. **R-E**

FLOPPYS

MANUFACTURER	MODEL	SIZE (Inches)	SECTOR TYPE (Hard/Soft)	NO. OF SECTORS (Per Track)	NO. OF TRACKS	FORMAT	DENSITY (Single/Double)	SIDES (Single/Double)	MAX. CAPACITY (K Bytes of Data Per Drive)	BUSS	CONTROLLER BOARD AVAIL (Y/N)	CONTROLLER BOARD INCL (Y/N)	OPERATING SYSTEM AVAIL (Y/N)	OPERATING SYSTEM INCL (Y/N)	EXTENDED BASIC AVAIL (Y/N)	EXTENDED BASIC INCL (Y/N)	PRICE
ALTOS COMPUTER SYSTEMS	ACS8000-1	8	S	26	76	IBM	S	S	500	ALTOS 50	Y	Y	Y	N	Y	N	$3,840.00
	ACS8000-2	8	S	26	76	IBM	S, D	S	500	ALTOS 50	Y	Y	Y	N	Y	N	$4,500.00
	ACS8000-3	8	S	26	76	IBM	S	D	1000	ALTOS 50	Y	Y	Y	N	Y	N	$4,800.00
	ACS8000-4	8	S	26	76	IBM	S, D	D	1000	ALTOS 50	Y	Y	Y	N	Y	N	$5,300.00
	ADD-2	8	S	26	76	–	S, D	S	1000	NA	Y	N	Y	N	Y	N	$2,960.00
	ADD-3	8	S	26	76	–	S, D	S	1000	NA	Y	N	Y	N	Y	N	$2,000.00
CENTRAL DATA CORP.	–	5½	S	9	35	256 BYTES/ SECTOR	S	S	81	S-100	Y	Y	Y[1]	Y[1]	Y[1]	Y[1]	$ 799.00
COMMODORE BUSINESS SYSTEMS	2040	5½	S	19	35	OWN	S	S	170	IEEE 488	Y	Y	Y	Y	NA	NA	TBA
COMPUTER INTERFACE TECHNOLOGY	CIT TRS-80	5½	S	10	40	–	S	S	64	TRS-80	Y	N	N	N	N	N	$ 499.00
COMPU/ THINK	DKH642	5½	S	–	40	–	S, D	S, D	400	PET	–	Y	–	Y	[6]	[6]	$1,295.00[7]
DATATRONICS	FD-277/99	8	S	26	77	IBM 3741	S, D	S, D	1200	S-100	Y	Y	Y	Y	Y	N	$1,995.00 UP
DYNABYTE INC.	DB 8/2	5½	S	32	77	IBM	S, D	S, D	630 (SS) 1200 (DS)	S-100	N	Y	Y	Y	Y	N	$4,395.00
	DB 8/4	8	S	52	77	IBM	S, D	S, D	1000 (SS) 2000 (DS)	S-100	N	Y	Y	Y	Y	N	$2,995.00
ELECTRO ANALYTIC SYSTEMS INC.	EAS-FDDS	8	S	26	77	IBM 3740	S, D	S, D	500	S-100 LSI-11 UNIVER-SAL	Y	Y	Y	N	Y	N	$2,195.00

MANUFACTURER	MODEL	SIZE (Inches)	SECTOR TYPE (Hard/Soft)	NO. OF SECTORS (Per Track)	NO. OF TRACKS	FORMAT	DENSITY (Single/Double)	SIDES (Single/Double)	MAX. CAPACITY (K Bytes of Data Per Drive)	BUSS	CONTROLLER BOARD AVAIL (Y/N)	CONTROLLER BOARD INCL (Y/N)	OPERATING SYSTEM AVAIL (Y/N)	OPERATING SYSTEM INCL (Y/N)	EXTENDED BASIC AVAIL (Y/N)	EXTENDED BASIC INCL (Y/N)	PRICE
FINDEX INC.	–	5½	S	–	–	–	D	D	–	S-100	Y	Y	Y	Y	Y	Y	–
	–	8	S	–	–	–	D	D	–	S-100	Y	Y	Y	Y	Y	Y	–
HEATH CO.	WH17	5½	H		40				102+	OWN	Y	Y					$ 675.00A
INNOTRONICS CORP.	410	8	H, S	26	77	IBM	S, D	S, D	789	PDP8	Y	N	Y	N	Y	N	$ 495.00
	420	8	H, S	32, 16, 8, 1	77	IBM	S, D	S, D	789	PDP11	Y	N	Y	N	Y	N	$ 505.00
	3400	8	H, S	–	77	IBM	S, D	S, D	789	LSI-11 S-100	Y	N	Y	N	Y	N	$1,555.00
ITHICA AUDIO	550	8	H	16	77	OWN	S	S, D	250 (SS) 500 (DS)	S-100	Y	N	Y	N	N	N	$ 456.00[2]
	552	8	H	16	77	OWN	S	S, D	250 (SS) 500 (DS)	S-100	Y	N	Y	N	N	N	$ 630.00[2]
MECA	DELTA-1	5½	H	10	35	–	D	S, D	–	S-100	Y	Y	Y	Y	Y	Y[3]	$ 744.00[4]
MIDWEST SCIENTIFIC INSTRUMENT	6800A	5½	S	16	77	OWN	S, D	S	160	SS-50	Y	Y	Y	N	Y	N	$2,995.00[5]
	FD-8	8	H	–	–	OWN	–	–	315	SS-50	Y	Y	Y	N	Y	N	$1,395.00
PERCOM DATA CO.	TFD-200	5½	S	10	35	256 BYTES/ SECTOR	S	S	–	TRS-80	Y[8]	–	Y[8]	–	Y[8]	–	$ 399.00
	LFD-400	5½	H	10	35	256 BYTES/ SECTOR	S	S	89	SS-50	Y	Y	Y	Y	Y	–	$ 599.95
PROCESSOR TECHNOLOGY	HELIOS II	8	18	32	77	ALTERED IBM	S	S	375	S-100	Y	Y	Y	Y	Y	Y	$3,200.00

MANUFACTURER	MODEL	SIZE (Inches)	SECTOR TYPE (Hard/Soft)	NO. OF SECTORS (Per Track)	NO. OF TRACKS	FORMAT	DENSITY (Single/Double)	SIDES (Single/Double)	MAX. CAPACITY (K Bytes of Data Per Drive)	BUSS	CONTROLLER BOARD		OPERATING SYSTEM		EXTENDED BASIC		PRICE
											AVAIL (Y/N)	INCL (Y/N)	AVAIL (Y/N)	INCL (Y/N)	AVAIL (Y/N)	INCL (Y/N)	
QUAY CORP.	80FDC	5½, 8	S	5½-16 8-26	5½-35 8-77	IBM 3740	S	S	5½-125 8-400	S-100	Y	N	Y	N	Y	N	$ 395.00
	90F/MPS	5½, 8	S	5½-16 8-26	5½-35 8-77	IBM 3740	S, D	S	5½-125/250 8-400/800	OWN	Y	N	Y	N	Y	N	$1,295.00[9]
RADIO-SHACK	261160[19]	5½	S	10	35	OWN	S	S	89.6	TRS-80	–	Y	Y	Y	–	Y	$ 499.00
	261161	5½	S	10	35	OWN	S	S	89.6	TRS-80	–	Y	Y	Y	–	Y	$ 499.00
SMOKE SIGNAL BROADCASTING	LFD-68	8	S	–	77	IBM	S	S	500	SS-50	N	Y	N	Y	N	Y[10]	$1,895.00[11]
SOUTHWEST TECHNICAL PRODUCTS CORP.	DMF-1A	8	S	32	77	FM	S	D	1200	SS-50	Y	Y	Y	Y	Y	Y	$2,095.00
	MF-68	5½	S	–	35	IBM	S	S	85	SS-50	Y	Y	Y	Y	Y	Y	$ 895.00K $ 995.00A
TARBELL ELECTRONICS	1011	5½ 8	S	26	77	IBM	S, D[12]	S, D	256SS	S-100	Y[13]	Y	Y[14]	N	Y[15]	N	–
THINKER TOYS	DISCUS 2D	8	S	26/8	77	IBM	S, D	S, D	600	S-100	Y	Y	Y	Y	Y	Y	$1,149.00
XITAN	ALPHA	5½, 8	S	5½-33 8-26/56	77	IBM	S, D	S	5½-330 8-512	S-100	Y	Y	Y	Y	Y	N	$2,195.00
NORTH STAR COMPUTERS[20]	MDS-A-D	5½	H	10	35	–	S, D	S, D	180	S-100	Y	Y	Y	Y	Y	Y	$ 699.00K $ 799.00A

NOTES:
NA NOT APPLICABLE
TBA TO BE ANNOUNCED
– NO INFO FROM MFR
SS SINGLESIDE
DS DOUBLESIDE

1 2650-BASED
2 ADD $175.00 W/CONTROLLER
ADD $ 75.00 W/COMPLETE SOFTWARE
3 ADD $195.00
4 +CP/M $98.00
5 WITH 32K PROCESSOR
6 INCLUDED AS PART OF PET BASIC
7 PLUS MEMORY COST
8 FROM RADIO-SHACK
9 WITH 16K RAM
10 AND FORTRAN
11 DUAL DRIVE
12 UNDER DEVELOPMENT
13 $190.00 KIT, $265.00 ASSMB.
14 CP/M $100.00
15 CBASIC-2 $100.00, TBASIC $36.00
16 BARE BOARD
17 USES DIGITAL RESEARCH CP/M
18 FIRM SECTOR/COMBINATION
19 INCLUDES TERMINATION RESISTOR ONE REQUIRED
20 TOO LATE TO ALPHABETIZE

CRT TERMINALS

MANUFACTURER	MODEL	TYPE	TYPE	INCLUDES KEY-BOARD (Y/N)	CAN USE AS STAND ALONE TYPE-WRITER (Y/N)	CHAR. PER LINE	CHAR. PER INCH	VAR-IABLE TYPE-FACES (Y/N)	LINES PER MINUTE	INTERFACE
BOOTSTRAP ENTERPRISES INC.	9112	THERMAL	MATRIX	N	N	12	10	N	60	PARALLEL
	9120	THERMAL	MATRIX	N	N	20	10	N	60	PARALLEL
CENTRONICS	P1	ELECTRO STATIC	MATRIX	N	N	80	8-10	N	–	PARALLEL
	S1	ELECTRO STATIC	MATRIX	N	N	80	8-10	N	–	PARALLEL
	779-1	IMPACT	MATRIX	N	N	80	8-10	N	–	PARALLEL
	779-2	IMPACT	MATRIX	N	N	80	8-10	N	–	PARALLEL
	703	IMPACT	MATRIX	N	N	80	8-10	N	600	PARALLEL
COMMODORE BUSINESS MACHINES	2020	IMPACT	MATRIX	N	N	80	10.6	N	70	PARALLEL
	2022	IMPACT	MATRIX	N	N	80	10.6	N	70	PARALLEL
	2024	IMPACT	MATRIX	N	N	80	10.6	N	70	PARALLEL
ELECTRONIC SYSTEMS	TRENDATA 1000	IMPACT	WHOLE CHAR	Y	Y	134 OR 155	10 OR 12	Y	–	SERIAL
FINDEX INC.	DEC WRITER	IMPACT	MATRIX	Y	Y	132	10	N	–	SERIAL
GRE DATA PRODUCTS	PRINTER-FACE II	IMPACT	MATRIX	N	N	40/80	5/10	Y	–	S-100
HEATH COMPANY	WH14	IMPACT	MATRIX	N	N	80, 96 132	–	N	–	PARALLEL SERIAL
	LA36 DEC WRITER	IMPACT	MATRIX	Y	Y	132	10	N	–	SERIAL
INTEGRAL DATA SYSTEMS INC.	IP-125[4]	IMPACT	MATRIX	N	N	80 (STD) 132 (OPT)	10 STD 8.3, 12, 16.5 (OPT)	N	50-80 CPS	SERIAL, PARALLEL
	IP-225[5]	IMPACT	MATRIX	N	N	80 (STD) 132 (OPT)	10 STD 8.3, 12 16.5 (OPT)	N	50-80 CPS	SERIAL, PARALLEL
INTERNATIONAL ELECTRONIC EQUIPMENT CORP.	ORIDATA CP110	IMPACT	MATRIX	N	N	80	10	N	70[6]	PARALLEL
INTERNATIONAL PERIPHERAL SYSTEMS INC.	1622	IMPACT	–	Y	Y	UP TO 300	5 TO 15	Y	TO 150	SERIAL PARALLEL

MANUFACTURER	ENCODED	CHAR. BUFFER-ING (Y/N)	HALF SPACING (Y/N)	PROPORT. SPACING (Y/N)	MECH-ANISM	HOUSING INCLUDED (Y/N)	PAPER		SHEET (Y/N)	WIDTH (Max. In.)	OTHER	PAPER	PRICE
							ROLL (Y/N)	WIDTH (Max. In.)					
BOOTSTRAP ENTERPRISES INC.	ASCII	Y	N	N	NEW	Y	Y	2½	–	–	–	THERMAL	$ 295.00
	ASCII	Y	N	N	NEW	Y	Y	2¼	–	–	–	THERMAL	$ 349.00
CENTRONICS	ASCII	Y	N	N	NEW	Y	–	–	–	–	–	ELECTRO-STATIC	$1,245.00 UP
	ASCII	Y	N	N	NEW	Y	–	–	–	–	–	ELECTRO-STATIC	$1,245.00 UP
	ASCII	Y	N	N	NEW	Y	Y	8.5	–	–	–	ANY	$1,245.00 UP
	ASCII	Y	N	N	NEW	Y	Y	14.5[2]	–	–	–	ANY	$1,245.00 UP
	ASCII	Y	N	N	NEW	Y	–	–					
COMMODORE BUSINESS MACHINES	ASCII	Y	N	N	NEW	Y	Y	8½	–	–		ROLL	$ 695.00
	ASCII	Y	N	N	NEW	Y	Y	8½	–	–		FORMS	TBA
	ASCII	Y	N	N	NEW	Y	Y	8½	–	–		EITHER	TBA
ELECTRONIC SYSTEMS	ASCII	Y	N	Y	REFUR-BISHED	Y	Y	15	Y	15	–	ANY	$1,395.00
FINDEX INC.	ASCII	Y	N	N	NEW	Y	–	–	–	–	–	–	$2,200.00
GRE DATA PRODUCTS	ASCII	Y	N	N	NEW	N	Y	8½	Y	8½	–	TELETYPE	$ 895.00
HEATH COMPANY	ASCII		N	N	NEW	Y	Y	9.5	Y	9.5	–	ANY	$ 895.00
	ASCII	Y	N	N	NEW	Y	Y	14⅞	Y	14⅞		TRACTOR	$1,495.00
INTEGRAL DATA SYSTEMS INC.	ASCII	Y	N	–	NEW	Y	Y	8.5	Y	8.5		ANY	$ 799.00
	ASCII	Y	N	–	NEW	Y	Y	8.5	Y	8.5		ANY	$ 949.00
INTERNATIONAL ELECTRONIC EQUIPMENT CORP.	ASCII	Y[7]	N	N	NEW	Y	Y	TTY PAPER	–	–	–	–	$ 650.00
INTERNATIONAL PERIPHERAL SYSTEMS INC.	ASCII EBCDIC	Y	Y	Y	NEW	Y	Y	14⅞	Y	14⅞	–	–	–

MANUFACTURER	MODEL	TYPE	TYPE	INCLUDES KEY-BOARD (Y/N)	CAN USE AS STAND ALONE TYPE-WRITER (Y/N)	CHAR. PER LINE	CHAR. PER INCH	VAR-IABLE TYPE-FACES (Y/N)	LINES PER MINUTE	INTERFACE
INTERNATIONAL PERIPHERAL SYSTEMS INC.	1612	IMPACT	–	Y	Y	UP TO 300	5 TO 15	Y	TO 150	SERIAL
M.P.I. INC.	TP-40	IMPACT	MATRIX	N	N	40	12	Y[1]	75	SERIAL
	IP-40	IMPACT	MATRIX	N	N	40	12	Y[1]	75	PARALLEL
	BP-40	IMPACT	MATRIX	N	N	40	12	Y[1]	75	PARALLEL
	SSP-40	IMPACT	MATRIX	N	N	40	12	Y[1]	75	SERIAL
	MP-40	IMPACT	MATRIX	N	N	40	12	Y[1]	75	PARALLEL
MICRO COMPUTER DEVICES, INC.	9710	IMPACT	WHOLE CHAR	Y	Y	135 OR 155	10 OR 12	Y	–	SERIAL PARALLEL
MICROMAIL	TC810	IMPACT	MATRIX	N	N	132	10 16.5 (OPT)	N	–	SERIAL
PRINTER TERMINALS CORP.	879	IMPACT	MATRIX	N	N	80 OR 132	–	N	75	SERIAL PARALLEL
PROCESSOR TECHNOLOGY	SOL	IMPACT	DAISY WHEEL MATRIX	N	–	130	1 TO 120	Y	–	SERIAL PARALLEL
RADIO SHACK	261150	IMPACT	DOT MATRIX	N	N	132	16.5	N	–	PARALLEL
	261152	IMPACT	DOT MATRIX	N	N	132	16.5	N	–	PARALLEL
	261151	ELECTRO-STATIC	DOT MATRIX	N	N	64	9	N	–	PARALLEL
	261153	ELECTRO-STATIC	DOT MATRIX	N	N	20-60	3.5-11	N	VARIES	PARALLEL
SOUTHWEST TECHNICAL PRODS	PR-40	IMPACT	MATRIX	N	N	40	12	N	70	PARALLEL
TELPAR INC.	PS-48C	THERMAL	MATRIX	Y	Y	48	10	N	30	ALL
VAMP INC.	IBM 745	IMPACT	WHOLE CHAR.	Y	Y	135	12	Y	–	PARALLEL

NOTES:

[1] DOUBLE WIDTH CHARACTERS
[2] 200 CHARACTERS
[3] 1 CHARACTER
[4] FRICTION FEED
[5] TRACTOR FEED
[6] BIDIRECTIONAL
[7] FULL LINE (80 CHARACTERS)
[8] MATRIX (YES), DAISY WHEEL (NO)

CPS (CHARACTERS PER SECOND)
TBA (TO BE ANNOUNCED)

MANUFACTURER	ENCODED	CHAR. BUFFER-ING (Y/N)	HALF SPACING (Y/N)	PROPORT. SPACING (Y/N)	MECH-ANISM	HOUSING INCLUDED (Y/N)	PAPER ROLL (Y/N)	PAPER WIDTH (Max. In.)	SHEET (Y/N)	WIDTH (Max. In.)	OTHER	PAPER	PRICE
INTERNATIONAL PERIPHERAL SYSTEMC INC.	ASCII EBCDIC	Y	Y	Y	NEW	Y	Y	14⅞	Y	14⅞	–	–	–
M.P.I. INC.	ASCII	Y[2]	N	N	NEW	Y	Y	17	Y	17	–	ANY	$ 749.00
	ASCII	Y[2]	N	N	NEW	Y	Y	4	N	–	–	ANY	$ 585.00
	ASCII	Y[2]	N	N	NEW	Y	Y	4	N	–	–	ANY	$ 585.00
	ASCII	Y[2]	N	N	NEW	Y	Y	4	N	–	–	ANY	$ 485.00
	ASCII	Y[3]	N	N	NEW	Y	Y	4	N	–	–	ANY	$ 425.00
MICRO COMPUTER DEVICES, INC.	ASCII	Y	N	N	NEW	Y	Y	15	Y	15	–	ANY	$1,850.00
MICROMAIL	ASCII	Y	N	N	NEW	Y	–	–	Y	15	–	TRACTOR ANY	$1,695.00
PRINTER TERMINALS CORP.	–	–	–	–	–	–	✓	–	–	–	–	–	$1,395.00
PROCESSOR TECHNOLOGY	ASCII DIRECT	8	Y	Y	NEW	Y	–	–	Y	14⅞	–	ANY	$3,695.00
RADIO SHACK	ASCII	Y	N	N	NEW	Y	Y	–8½	Y[1]	8½	LABELS CARBON	ANY	$1,299.00[1]
	ASCII	Y	N	N	NEW	Y	Y	8½	Y[1]	8½	LABELS CARBON	ANY	$1,599.00[2]
	ASCII	Y	N	N	NEW	Y	Y	4	N	NA	–	ELECTRO-STATIC	$ 599.00
	ASCII	Y	N	N	NEW	Y	Y	6	N	NA	–	ELECTRO-STATIC	$ 499.00
SOUTHWEST TECHNICAL PRODS	ASCII	Y	N	N	NEW	Y	Y	3⅞	–	–	–	ANY	$ 250.00
TELPAR INC.	ASCII	Y	N	N	NEW	Y	Y	5.5	–	–	–	THERMO	$ 700.00
VAMP INC.	ASCII	Y	Y	Y	REFUR-BISHED	Y	Y	14	Y	14	–	–	$ 750.00

CRT TERMINALS

MANUFACTURER	MODEL	PARALLEL I/O: NO. LINES	PARALLEL I/O: HAND-SHAKING	PARALLEL I/O: COMPAT-IBILITY	SERIAL I/O COMPAT-IBILITY	KEYBOARD: NO. KEYS	KEYBOARD: NO. USER DEFINABLE KEYS	KEYBOARD: CURSOR	KEYBOARD: UPPER CASE	KEYBOARD: LOWER CASE	VIDEO DISPLAY: GRAPHICS	VIDEO DISPLAY: COLOR	VIDEO DISPLAY: RESO-LUTION	TEXT: CHAR. PER LINE	TEXT: NO. LINES	TEXT: DOT MATRIX	TEXT: SCROLL-ING	TEXT: BLACK ON WHITE	TEXT: WHITE ON BLACK	TEXT: HIGH-LIGHTING	TEXT: UPPER CASE	TEXT: LOWER CASE	PRICE
DATATRONICS		9	Y		RS-232C	91	8	AD	Y	Y	Y	N	–	80	25	7x9	Y	Y	Y	Y	Y	Y	$ 995.00
FINDEX INC.		46	Y		RS-232C	77	0	Y	Y	Y	N	N	–	40	6	Y	Y	–	–	–	Y	Y	–
HAZELTINE	1500	–	–	–	TTY RS-232	74	0	Y	Y	Y	N	N	–	80	24	7x10	Y	Y	Y	Y	Y	Y	$1,225.00
	1510	–	–	–	TTY RS-232	81	0	Y	Y	Y	N	N	–	80	24	7x10	Y	Y	Y	Y	Y	Y	$1,395.00
	1520	–	–	–	TTY RS-232	81	0	Y	Y	Y	N	N	–	80	24	7x10	Y	Y	Y	Y	Y	Y	$1,650.00
	1400	–	–	–	TTY RS-232	53	0	Y	Y	N	N	N	–	80	24	5x7	Y	N	Y	N	Y	N	$ 850.00
HEATH	H9	–	–	–	RS-232C	67	N	Y	Y	N	Y	N	–	80 20	12 48	5x7	Y	N	Y	N	Y	N	$ 530.00K
MICROMAIL	SOROC 1Q120	–	–	–	RS-232C	69	0	Y	Y	Y	N	N	–	80	24	5x9	Y	N	Y	Y	Y	Y	$ 795.00
	SOROC 1Q140	–	–	–	RS-232C	102	32	Y	Y	Y	N	N	–	80	25	5x9	Y	Y	Y	Y	Y	Y	$ 345.00
MICRO-TERM INC.	ACT V/ MIME	–	–	–	RS-232C	63	0	Y	Y	Y	N	N	–	80	24	5x9	Y	N	Y	Y	Y	Y	$ 795.00 $ 865.00
	ACT-IA	–	–	–	RS-232C	63	0	Y	Y	Y	N	N	–	64	16	5x9	Y	N	Y	Y	Y	Y	$ 400.00
NETRONICS		–	–	–	RS-232C	53	–	Y	Y	Y	N	N	–	34 64	16	5x7	Y	N	Y	N	Y	Y	$ 149.00
PHONE 1 INC.		–	–	TTY3277	RS-232	74	–	Y	Y	Y	32 CHAR	N	80x 24	80	24	7x9	Y	–	Y	Y	Y	Y	$ 850.00
RADIO SHACK					–	53	0	Y	Y	N	Y	N	127 X 47	64	16	Y	Y	N	Y	N	Y	N	$599.00
SMOKE SIGNAL BROADCASTING		3	Y	S-100	S-100	72	46	Y	Y	Y	Y	N	–	64	16	8x10	Y	N	Y	Y	Y	Y	$ 625.00
SOUTHWEST TECH. PRODUCTS INC.		8	Y	–	RS-232	68	–	Y	Y	Y	Y	N	–	80	20	7x12	Y	1	2	N	Y	Y	$ 795.00
TELECOMMUNI-CATIONS SER. CO.	3360	25	N		RS-232	–	–	Y	Y	N	N	N	–	82	–	5x7	OPT	–	1	N	Y	N	–
	3000	25	Y		RS-232	–	–	Y	Y	N	N	N	–	72	–	–	Y	–	1		Y	N	–
U.S. ROBOTICS INC.		–	–	–	RS-232C	66	–	Y	Y	Y	N	N	–	80	24	7x10	Y	Y	Y	N	Y	Y	$ 799.00
VECTOR GRAPHICS		1	N		NO	71	0	Y	Y	Y	Y	N	900 LINES	80	24	Y	Y	Y	Y	Y	Y	Y	$ 765.00

NOTES: K KIT
A ASSEMBLED
[1]WHITE ON GREEN
[2]GREEN ON BLACK
[3]RED
[4]LIMITED
[5]USER SELECTABLE

String Synthesizer

Part 2—Continuing the discussion of the electronic string music synthesizer. This unique instrument gives the soloist and small groups the background needed to enhance performance

MARVIN JONES

BEFORE PRESENTING THE CONSTRUCTION details, we will conclude the circuit discussion started last month with a description of the middle-octave mixing and chorusing circuit and the power supply.

The middle-octave piano keying circuit is exactly like the high- and low-octave circuits, but the middle-octave strings section is slightly different to accommodate the switchable split-keyboard feature. The string keying starts off the same; C6 charges through R15 and D17, and the sustain control affects the discharge time of C6 via R16 and D18. Resistors R17 and R18 apply the envelope voltage of C6 to two diode keying networks—one for violins, one for cellos. Here the differences begin. The two diode keying circuits are designed to each provide two identical outputs. The basic philosophy behind the split keyboard circuitry is: "Feed an identical signal to both the upper **AND** lower mix buses, and remove the one you **DON'T** want."

So where the low-octave strings are connected to the appropriate low-mix buses and the high-octave strings are connected to the high-mix buses, the middle-octave strings are simultaneously applied to both. The logic level available on the split select bus (SPL) is used to determine which of the two signals will be grounded out. The voltage levels on the SPL bus are directly related to the front panel switch position. Low-octave split point is represented by a low voltage. High-octave split point is represented by +V appearing on the SPL bus. The single NAND gate (IC3-c) remaining from the waveshaping circuit is used to invert the SPL signal. When the front panel split switch is at position 1, the keyboard is being split between the low and middle octaves. Thus, you want the middle octave to be applied to the high-mix bus.

So, the ground potential appearing at the SPL bus is used to forward bias the shunt diodes, D31 and D32, causing the low-string mix signals from the middle octave to be shunted to ground. The diodes connected to the high-string mix buses, D29 and D30, are being driven by the SPL inversion which is now at a high level. Thus, the diodes are inactive. When the SPLIT switch is in the high, or No. 2 position, the SPL bus is at a high level allowing the signal to pass to the low-mix bus. The inverter now produces a low output, shunting the high-mix signals to ground.

The chorusing circuitry is shown in Fig. 4. Most of this circuitry is contained on one PC board, with the exception of front panel controls, jacks, and so on. The resultant signal mixes from the front panel HIGH and LOW mix controls are applied to string inputs A, B, C and D. IC10-a serves as a unity-gain mix and buffer amplifier. Capacitor C20 rolls off the high-frequency content of the input signal to avoid any intermodulation with the clocking frequency of the analog delay lines. Bias trimmer, R66, sets a DC level at the output of the buffer (IC10-a) so the analog delay lines will be biased for minimum distortion and maximum dynamic range. The buffered input signal is applied to two delay lines (IC8 and IC9) plus the output amplifier, IC11.

Thus, the composite string signal at the output consists of one original signal and two independently delayed and modulated signals. In one path, the signal is delayed by IC8-a and dropped across the delay line load, R69. Capacitor C23 eliminates the high-frequency clocking signal that is superimposed on the audio signal as it passes through the delay line. Op-amp-IC10-b is a gain stage to make up for losses encountered in the delay line and C25 provides additional filtering of high frequencies to help smooth the audio signal. The output of IC10-b, which also rides the bias level determined by R66, is passed through another stage of analog delay, IC8-b. The delay line output is again filtered and applied to the output mix amplifier, IC11. Delay time IC9 and its associated circuitry operates identically to the delay line circuitry of IC8. This second independent delay line has its signal also applied to the output mix amplifier.

The remaining stage of IC10 is used to buffer and drive the piano signal outputs. The signal from the piano mix bus (MXP) is dropped across R86, and buff-

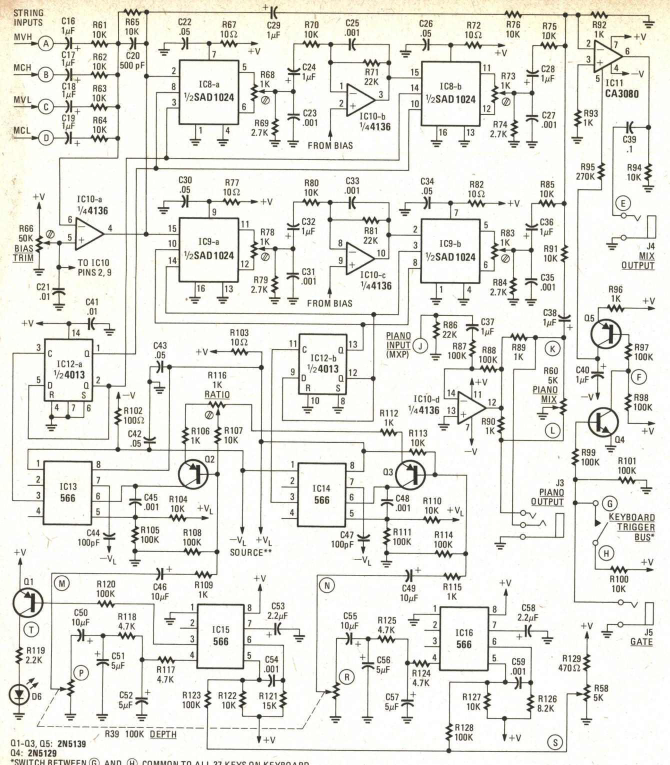


FIG. 4—THE CHORUSING CIRCUITRY where tones from the note generators are combined and processed. The analog delay lines are in IC's 8 and 9.

ered by IC10-d. At the output (pin 12) of the buffer, the piano signal is split and supplied to two possible paths. One is directly to the PIANO solo output, and the other is to the master output mix amplifier, IC11. PIANO MIX control, R60, can be used to shunt various amounts of either signal path to ground. Also note that the on-board piano signal path that leads to the master output mix is connected to the piano jack via point K. This connection would normally connect to the ring section of a 3-conductor phone plug inserted in J3. However, when the more commonly used 2-conductor plug is inserted, the ring connection will be shorted to the grounded sleeve connection thus disabling the piano signal at the MIX OUTPUT. The combination of three string signals and one piano signal which are to be applied to output amplifier IC11 are dropped across R92. As well as being a mixing and buffer amplifier, IC11 also serves as a noise gate.

Due to the operational characteristics of the analog delay lines, there is typically a good deal of switching noise superimposed in the audio signal when it comes out of the delay IC's. This translates into a "hissing" effect which is normally masked by the larger amplitude signal. However, when there is no signal present at the delay lines the hissing output can

be annoying—especially if you are on stage, running the synthesizer through several hundred watts of amplification. So the noise gate action of IC11 allows a signal to pass to the output **ONLY** when a key is depressed on the keyboard. Normally, C40 will be discharged and there will be no control current being applied to pin 5 of the CA3080, IC11. With no control current applied to the IC, there is no amplification by the IC—and thus no output. When any key of the keyboard is pressed, the trigger bus switch contacts will close. The resultant shorting of points "G" and "H" causes a voltage to appear at the GATE output jack, J5, and at the base of Q4.

When Q4 conducts, Q5 will also turn on. When Q5 conducts, C40 will charge through R96 towards +V. The charging time constant of C40/R96 is selected to be slightly less than the attack time of the diode keying in the string sections of the tone blocks. When C40 is fully charged, the current through R95 to IC11 drives the output to the desired level for interface with most guitar amplifiers or PA systems. When all keys on the keyboard are released, Q4 and Q5 turn off. The impedance looking back into the collector of Q5 is very high, thus leaving R95 as the only discharge path for C40. The discharge time constant of R95/C40 is selected to be slightly longer than the longest sustain times available from the string tone block circuitry. Therefore, the long sustained string passages should never be "cut off" by the output noise gate.

The circuitry shown in the lower half of Fig. 4 is the control circuitry for the analog delay lines. Front panel RATE control R58 sets the desired control voltage to be applied to low-frequency vibrato oscillators IC15 and IC16. The variations in voltage drive the vibrato oscillators to selected frequencies. Although the timing capacitors for these oscillators (C53, C58) are the same, the timing resistors (R121, R126) are slightly different. This causes the pseudo-random beating and chorusing required to get the string effects. Capacitors C54 and C59 suppress parasitic oscillations at each oscillator IC.

Since the pitch deviations generated within the analog delay lines are related to the mathematical derivative of the signal used to modulate the high-frequency clock, we need to have a sinewave modulation signal in order to obtain the common smooth sinewave type (actually cosine would be mathematically correct) vibrato. The closest thing available as an output from the vibrato oscillator IC's is a triangle wave at pin 4. This signal is run through a 2-pole passive filter to smooth it into a sine shape, and the resulting signal from each oscillator is applied to a section of the dual-section DEPTH control, R59. The squarewave output of IC15 at pin 3 is used to control the LED driver Q1 for a visual indication of vibrato rate.

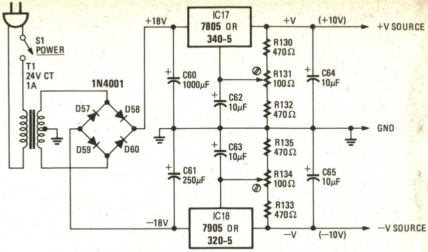


FIG. 5—POWER SUPPLY for the synthesizer uses center-tapped transformer and a full-wave bridge rectifier to deliver equal positive and negative voltages.

The selected amount of low-frequency modulation signal is fed to the high-frequency delay line clocks, IC13 and IC14. Transistors Q2 and Q3 serve as current sources which replace the customary timing resistors at pin 7 of the high-frequency oscillators. The small value timing capacitors, C44 and C47, result in clock frequencies up around several hundred kHz.

With the use of current sources to drive the timing resistor inputs of these IC's, a fairly small voltage fluctuation can be used to effectively sweep the clock frequency over a wide range, as opposed to the modulation inputs of the IC's at pin 5 which typically only cause deviations of about 2:1.

The delay lines require a bi-phase clock signal, preferably providing squarewaves and generating as little overlap during switching periods as possible. To accomplish this, the squarewave outputs of the high-frequency oscillators are fed through a CD4013 D-type flip-flop. With the flip-flop connected as a frequency divider, the two output pins (pins 1 and 2 for one divider, pins 12 and 13 for the other) provide nice, clean complementary squarewaves to drive the delay lines.

The continuous changing of the clock speeds for the delay lines causes a periodic shifting of the pitch of the audio signal applied to the delay line. The input signal for the delay line is sampled periodically at a rate determined by the delay-line clock frequency. If, when the signal gets to the end of the delay line, the clock happens to be running faster than when the signal was clocked in, the pitch of that signal will be shifted up slightly. The signal is being pushed **OUT** of the IC faster than it was taken in. Similarly, if the clock happens to be running slower than when the signal was clocked in, the pitch will be shifted down slightly.

Ratio trimmer, R116, is a means of providing slight adjustments in the center frequencies of the two high-frequency clocks. Since these two clocks are contained on the same circuit board near each other and near the audio circuitry of IC10 and IC11, it is possible that the two independent clocks could beat against each other and induce or transmit audible beat frequencies into the signal path. With R116, you can slightly alter the ratio of one clock frequency to the other, thus setting up a ratio where the beat frequencies fall outside audibility and make the chorusing circuit even quieter.

Networks R102/C42 and R103/C43 provide current limiting and supply line decoupling for the high-frequency circuitry. The current limiting also reduces the power consumption of the 566 high-frequency oscillators and puts them in a safer operating range.

The power supply for the entire string synthesizer is shown in Fig. 5. All active components for the supply are contained on the same PC board that contains the chorusing circuitry. A 24-volt RMS center-tapped transformer drives a bridge rectifier (D57-D60) and primary filters C60 and C61 to initially provide ±18 volts DC. Transistors Q6 and Q7 provide regulation of the supply. Although these are 5-volt regulators, the resistive network at the outputs biases the regulators up to around 10- or 12-volt outputs, depending on resistor tolerances. Capacitors C64 and C65 increase the transient response of the supply, while C62 and C63 help stabilize the new reference voltages which are increasing the output voltage of the regulators. A small degree of trimming is allowed for in the power supply. The ratios of supply voltages can aid in achieving minimum switching noise and intermodulation from the chorusing circuit. This is a relative adjustment and is interactive with the ratio trimmer, R116. In most cases, the supply trimmers can be left at mid-position.

The PC boards

Most of the circuitry and construction techniques are straightforward so little explanation is required. Note well that

this is a **BIG** project. There are four PC boards—two are approximately 24 by 6 inches. You'll need all your prior experience as well as larger etching equipment. Your best bet may be to order the PC boards from the source listed in the parts list.

The two large boards are almost identical as each contains six of the twelve identical tone blocks. The block drawings in Fig. 6 show the order of the tone blocks

PARTS LIST FOR POWER SUPPLY

Resistors ¼ watt, 10% or better
R130, R132, R133, R135—470 ohms
R131, R134—100 ohms trimmer pot
C60—1000 μF, 20 volts
C61—250 μF, 20 volts
C62-C65—10 μF, 10 volts
D57-D60—1N4001
S1—SPST switch
T1—power transformer, 24 VCT, 1A
IC17—LM340-5 or 7805
IC18—LM320-5 or 7905

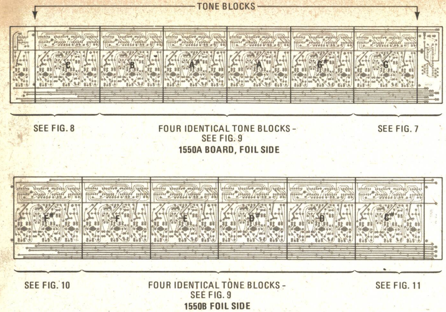


FIG. 6—HOW THE TONE BLOCKS ARE ARRANGED on the two large PC boards. On board 1550A there is additional circuitry at the ends of the six tone blocks.

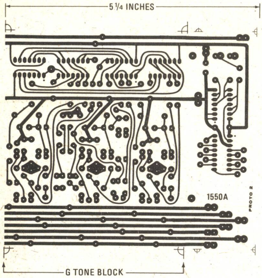


FIG. 7

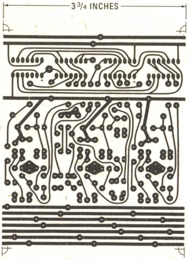


FIG. 9

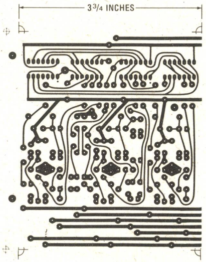


FIG. 10

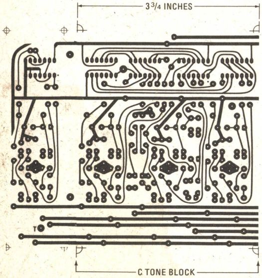


FIG. 8

HALF-SIZE SECTIONAL FOIL PATTERNS. Figs. 7 and 8 are right and left ends, respectively, of the "A" board. Fig. 9 pattern is used when making the four tone blocks in the center of boards "A" and "B". Fig. 10 is the F# block and Fig. 11 the C# block on the "B" board.

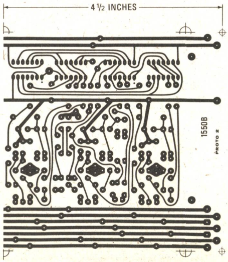


FIG. 11

on the 1550A and 1550B PC boards. The 1550A board has some additional circuitry on each end and so is a little longer than the 1550B board. Figures 7 and 8 show the foil patterns for the circuitry at the right and left ends and for the G and C tone blocks. The foil pattern in Fig. 9 is repeated four times between the G and C tone blocks.

Similarly, Figs. 10 and 11 are the foil patterns for the F and C tone blocks at the ends of the 1550B board. The pattern in Fig. 9 is repeated four times as on the 1550A board. Figure 12 shows the parts placement on the ends of the 1550A board. The components in all twelve tone blocks are positioned as in the C-note block in Fig. 12. Figure 13 shows the connections to the left end of the B board.

continued on page 104

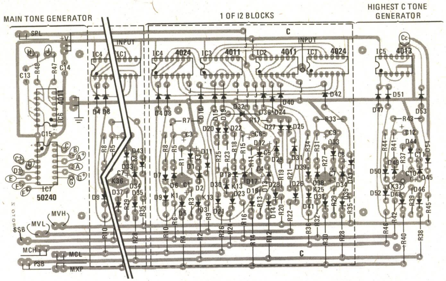


FIG. 12—PARTS PLACEMENT diagram shows the location of components on each of the twelve tone blocks and the main tone generator and the high-C generator on the ends of the 1550A board.

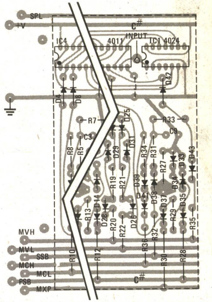


FIG. 13—CONNECTIONS that are to be made on the left end of the 1550B circuit board.

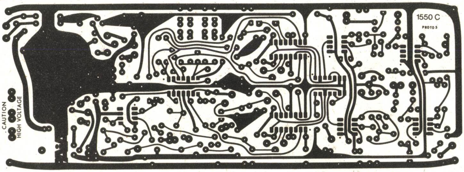
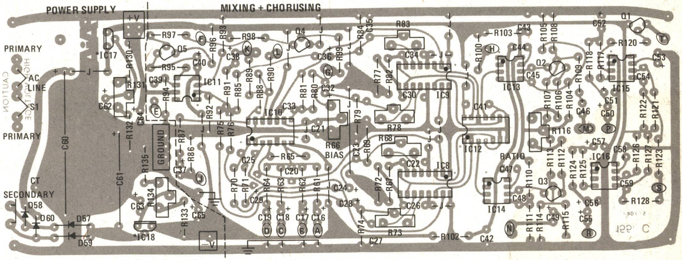


FIG. 14—HALF-SIZE FOIL PATTERNS for the 1550C board. Power supply components are on the extreme left edge. Mixing and chorusing circuits occupy the balance of the board.

PARTS LIST FOR ONE OF 12 IDENTICAL TONE BLOCKS

Resistors ¼ watt, 10% or better

R1, R11, R27—1000 ohms
R2, R3, R5, R7, R8, R12, R13, R16–R18, R28, R29, R32–R34—10,000 ohms
R4, R14, R19–R26, R30—100,000 ohms
R5, R15, R31—2200 ohms
R9, R10, R35, R36—220,000 ohms
C1, C2, C4, C5, C7, C8—10 μF, 10 volts electrolytic
C3, C6, C9—33 μF, 10 volts electrolytic
D1–D43—1N914 diode



NOTES: *IC17 AND IC18 REQUIRE HEATSINKS.
TERMINALS MARKED BY CIRCLED LETTERS CONNECT TO SIMILARLY MARKED TERMINALS ON OTHER BOARDS.

FIG. 15—PLACEMENT OF COMPONENTS on the "C": board. All points marked by letters enclosed in circles must be connected to similarly indicated points on other boards.

Audio Test Station

PART 3—A continuation of the series describing the operation and construction of the model 101 audio test system. This month we cover the pulse generator, sweep shaper and audio sweep generator.

RAY DAVISON

THIS IS THE THIRD OF A SERIES OF ARTICLES describing the *model 101* Audio Test System by Fidelity Sound. In the January issue we presented an overall picture of this versatile instrument. Last month we began with a technical description and construction details on the power supply and timebase generator.

This month we will cover the pulse generator, sweep shaper and the audio sweep generator—providing technical discussions, assembly details and calibration and alignment instructions.

Pulse generator

The pulse generator (Fig. 5) is simply a monostable multivibrator (one-shot) that produces a single pulse at the beginning of each cycle of the timebase. The one-shot is triggered by the output from timebase squarewave buffer Q201. The one-shot has complementary outputs; that is, they are always at an opposite logic level. When the one-shot is triggered by Q201 the outputs change state. They remain in this new state for a period of time that is determined by the combination of the capacitor selected by S7 and the total resistance between pin 11 and the positive supply.

After this period of time has elapsed, the outputs return to their original state. This is why the device is called a monostable. It is stable in one state. It can be forced to change state and held in that new state. However, it returns to its original state after the charge on the capacitor, which was holding it in the new state, has sufficiently diminished.

With the components shown, the pulse generator is capable of providing pulse widths ranging from about 40 nanoseconds to about 3 seconds. The front-panel controls show a minimum pulse width of 20 nanoseconds. However, the rise and falltimes converge at about 30 nanoseconds and this establishes the minimum pulse width.

Pulse-width accuracy is a simple function of the cost of the timing components. Slide potentiometer R5 is quite linear and therefore poses no inherent restriction. The remaining variable then is the capacitor selected by switch S7.

These capacitors need not be of any particular type. For the values from 10 pF thru 0.1 μF 5% ceramic or film is probably adequate for most applications. For the values of 1 μF to 100 μF, aluminum electrolytics are the smallest and least expensive. They are available in tolerances from ±10% to −20% and +100%. If greater accuracy is demanded in these ranges, then tantalum is probably the best choice.

Both outputs have over-voltage sensors to protect against the application of an external voltage, as was discussed in the timebase section. The recommended devices are $20 each. They are optional and not part of the standard parts kit, and the circuit board has been set up to accommodate several different types.

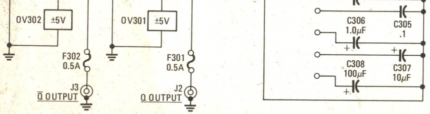
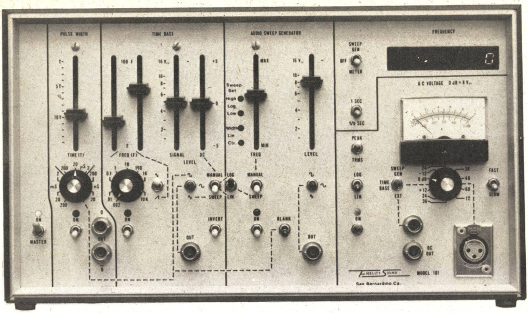


FIG. 5—THE PULSE GENERATOR is perhaps the simplest of the system's circuits. Pulse widths are adjustable from 40 nS to 3 seconds.

The sweep shaper

The audio sweep generator shown, in Fig. 6, has both log and linear sweep modes. One of these is selected by switch S12. The oscillator produces a frequency change proportional to the sweep voltage applied to it. Therefore, for a linear sweep, the sweep shaper (the timebase-to-sweep-generator interface) need only provide the proper amplitude and offset. Trimmers R10 and R409 establish the magnitude of the sweep signal while R11,



R410, and R411 establish the offset. Resistors R10 and R11 are 20-turn trimmers accessible through the front panel. Resistor R10 is labeled LINEAR SWEEP WIDTH and R11 is LINEAR SWEEP CENTER frequency.

For a log sweep, the change in frequency at any point on the frequency scale is proportional to the frequency at that point. For example, if a straight line is divided into 10 equal length segments, there will be 11 marks including the one that closes off the 10th segment. If the first mark is labeled 20 Hz, then each successive mark is twice the frequency of the preceding mark. The end marks will have a frequency of 20 Hz and 20,480 Hz. The change in frequency between the first two marks is only 20 Hz. The change between the last two marks is 10,240 Hz. This then is a *10-octave range* because the frequency doubled 10 times. This function is generally referred to as a log sweep.

For linear sweep voltage to sweep a linear VCO (voltage-controlled oscillator) in the above manner, the sweep voltage must be conditioned so that it changes very slowly at the beginning of the sweep and increases the rate of change as the sweep continues. The action just described is *not* a log function but an *antilog* function. Therefore, to convert a linear sweep to a log sweep we need an antilog converter not a log converter.

IC402 is an antilog amplifier. Op-amp IC401 inverts the incoming control voltage before it is applied to IC402, the antilog amplifier. Pots R8 and R9 are the log sweep set trimmers. The output of IC402 is effectively clamped at zero. Therefore, R8 effects primarily the peak amplitude of the waveform and hence the high-frequency end point of the sweep. Trimmer R9 adjusts the base of the waveform around zero. It shifts the entire waveform, but we call it the low-frequency sweep end-point control because its effect on the high-frequency end-point is relatively insignificant compared to its effect on the low-frequency end-point. Trimmer R412 provides a slight amount of linear sweep at the beginning of the sweep to compensate for a slight lag in the overall sweep generator circuit.

Audio sweep generator

The schematic in Fig. 7 shows the audio sweep generator circuit. The waveforms are generated by oscillator IC502. The frequency range is set by C501 connected between pins 2 and 30. The minimum frequency is established by R507. The frequency is increased by applying a negative control voltage to R506. This resistor changes the voltage signal to a current signal. With switch S11 in the SWEEP position, the linear or log signal, as selected by S12, is applied to the inverting input of IC501. Feedback resistor R505 combines with the various output resistors of the sweep-signal conditioning section to provide the desired

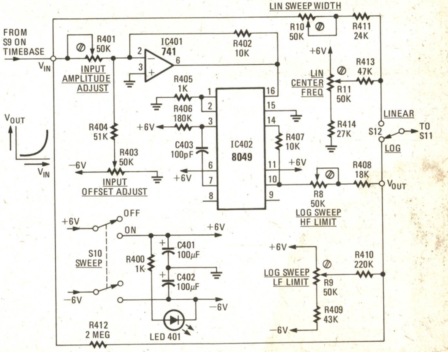
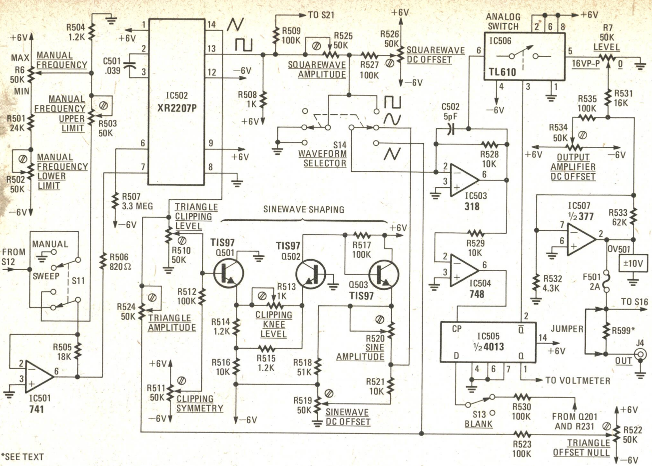


FIG. 6—THE SWEEP SHAPER processes the timebase signal and drives the sweep generator with either a linear or log-sweep.



*SEE TEXT

FIG. 7—THE AUDIO SWEEP GENERATOR is basically a voltage-controlled function generator that provides sine, square and triangular waveforms.

current to the oscillator sweep input.

When S11 is switched to MANUAL the sweep voltage is provided by R6, the MANUAL frequency control on the front panel. The other half of S11 grounds the timebase sweep signal when it is not being used. Otherwise, this signal can be coupled across the contacts of S11 and modulate the oscillator frequency.

The front-panel markings on frequency control R6 have no numerical calibration, but rather just minimum and maximum points. It is customary for a function generator to have a calibrated frequency-control dial. However, with this system, the built-frequency counter gives far greater accuracy and resolution than would be possible with a calibrated dial. Trimmers R502 and R503 allow the user to select his own minimum and maximum points. For instance, if the unit is going to be used for telephone frequencies, the sweep can be narrowed to that spectrum. Resistor R504 is in parallel with R501, R502 and the bottom portion of R6. With R502 set for a 20-Hz low-frequency limit, the result is a logarithmic frequency control from R6. The various signals, thru their respective trimmers, are summed into IC503 to provide equal amplitude waveforms with zero offset.

The circuit at the output of the oscillator provides a tone burst. The oscillator output passes thru analog switch IC506 and on to the IC507 output stage. The signal used to gate analog switch (IC506) originates at Q201. Flip-flop IC505-a is a data or D-type flip-flop. It will pass data from the D input to the output only during the positive transition of the clock input. Op-amp IC503 is connected as a comparator that is used as a zero-crossing detector. The 748 op-amp, incidentally, makes an excellent comparator. It will do an excellent job at 20-kHz, whereas most of the comparators that have been considered standard for some time cease to function well below that.

That data to be transferred by IC505 is the tone-burst gating signal from the timebase section. The clock is a squarewave corresponding to the zero-crossings of the waveform or burst to be gated. Assume that the gating signal at the D input switches from high to low. This is ignored until the output of IC504 switches from low to high, thus indicating that a waveform out of IC503 has crossed zero in a negative-going direction. At this point the outputs of the flip-flop change state: $\overline{Q}$ goes high. This causes analog switch (IC506) to close and pass the output of IC503 as it crosses zero in the negative direction.

When the gating signal and flip-flop output go high, this data is likewise held until the output of IC504 switches from low to high. This indicates that a waveform from IC503 has again crossed zero in a negative-going direction. Thus, the tone-burst circuit produces only complete waveforms with the beginning at zero and ending at zero.

Note that IC504 is an inverting comparator and that IC507 is also an inverter. Thus, the waveforms as seen at the output start and end in a positive-going direction, which isn't any more useful but seems more "comfortable" when viewed on the scope.

Note that switch S13 on the front panel is labeled BLANK. Its function is to blank the output of the audio sweep generator during the return sweep to provide a zero reference line and to avoid overlaying a retraced plot. Recall that IC506 is switched on when the gating signal at S13 goes low. The output of Q201 (in the timebase generator, Fig. 4) goes low as the ramp output of the timebase begins a positive-going ramp. Therefore, with switch S13 in the BLANK position the output of the audio sweep generator is on during a positive-going timebase ramp.

The output of IC506 goes to R7, the front-panel LEVEL or amplitude control. The output circuitry is identical to that of the timebase section, except that there is no DC offset. The combination of R531 and R7 produces an audio taper at R7. This produces a potentiometer curve similar to a volume control. Again the output over-voltage protection is optional, and the board accepts alternate devices.

(continued on page 81)

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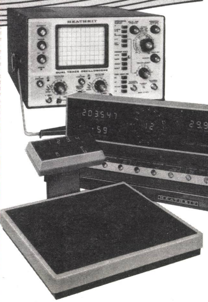
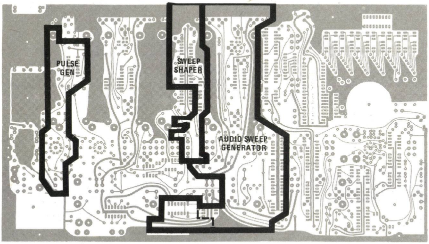


Heath Company

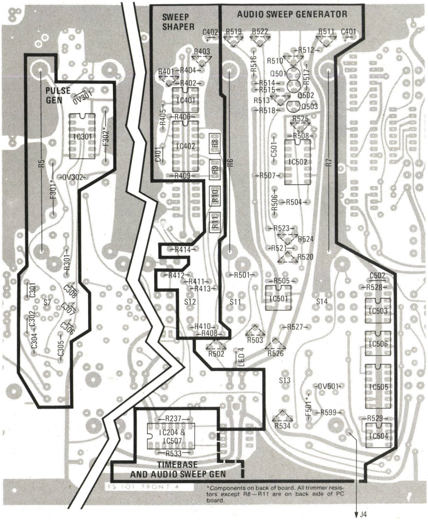
BENTON HARBOR MI 49022

PARTS LIST FOR PULSE GENERATOR

R5—50,000 ohms, linear pot
R301—3000 ohms
C301—10 pF
C302—100 pF
C303—.001 μF
C304—.01 μF
C305—0.1 μF
C306—1 μF
C307—10 μF
C308—100 μF
IC301—74121 monostable multivibrator
D301, D302—1N4001
OV301, OV302—LVC-1A5.1 (MCG Electronics, 160 Brook Ave., Deer Park, NY 11729)
F301, F302—0.5 amp fuse
J2, J3—panel-mount BNC connectors
S7—single-pole 10-position rotary switch



CIRCUIT LOCATION of the pulse generator, sweep shaper and audio sweep generator with respect to the entire PC board.



COMPONENT LOCATION. Use the diagram above to locate these sections on the PC board.

PARTS LIST FOR SWEEP SHAPER

All resistors ¼-watt, 5% carbon film unless otherwise noted.
R8–R11—50,000 ohms, 10-turn pot
R400—1,000 ohms
R401, R403—50,000 ohms, linear slide pot
R402—10,000 ohms
R404—51,000 ohms
R405—1000 ohms
R406—180,000 ohms
R407—10,000 ohms
R408—18,000 ohms
R409—43,000 ohms
R410—220,000 ohms
R411—24,000 ohms
R412—2 megohms
R413—47,000 ohms
R414—27,000 ohms
C401, C402—100 μF, 16 volts or higher
C403—100 pF disc
IC401—741
IC402—8049 (Intersil)
LED401—
S10—DPST toggle
S12—SPDT toggle

PARTS LIST FOR AUDIO SWEEP GENERATOR

All resistors ¼-watt, 5% carbon film unless otherwise noted.
R6, R7—50,000 ohms, linear slide-type potentiometer
R501—24,000 ohms
R502, R503, R510, R511, R519, R520, R522, R524–R526, R534—50,000 ohms, trimmer pot
R504, R514, R515—1200 ohms
R505—19,000 ohms
R506—820 ohms
R507—3.3 megohms
R508—1000 ohms
R509, R512, R517, R523, R527, R530, R535—100,000 ohms
R513—1000 ohms, trimmer pot
R516, R521, R528, R529—10,000 ohms
R518—51,000 ohms
R531—16,000 ohms
R532—4300 ohms
R533—62,000 ohms
C501—.039 μF disc
C502—5 pF disc
IC501—741
IC502—XR2207P
IC503—LM318
IC504—LM748
IC505—4013
IC506—TL610 (Texas Instruments)
IC507—377
Q501–Q503—TIS97 (Texas Instruments)
OV501—LA10 (MCG Electronics)
F501—2 A fuse
J4—panel-mount BNC connector
S11—DPDT toggle switch
S13—SPDT toggle switch
S14—DP 3-position toggle switch

The following are available from FSI, 1894 Commercenter W., No. 105. San Bernadino, CA 92408: Complete kit, $495.00; cabinet and circuit board, $115.00. Set of semiconductors, $195.00; seven slide pots with knobs, $17.00, set of trimmers including four multiturn pots, $17.00.

California residents add state and local taxes as applicable.

MASTER PARTS LIST

The following is a list of all the components and the quantity necessary to build the complete *model 101* Test Station. However, it is not necessary to build a complete Test Station. Each section will work independently of the other sections (except for the power supply) so that you can build any or all of the sections you desire. Subtract any components you already have. What you will need to complete the *model 101.*

All resistors ¼-watt, 5% carbon film unless otherwise noted

1—100 ohms
2—310 ohms
7—330 ohms, 1 watt
2—820 ohms
9—1000 ohms
5—1200 ohms
1—1500 ohms
2—2200 ohms
1—2700 ohms
2—300 ohms
2—4300 ohms
5—7500 ohms
19—10,000 ohms
1—12,000 ohms
3—15,000 ohms
2—16,000 ohms
3—18,000 ohms
2—22,000 ohms
2—24,000 ohms
1—27,000 ohms
2—30,000 ohms
1—43,000 ohms
1—47,000 ohms
3—51,000 ohms
2—62,000 ohms
1—75,000 ohms
1—82,000 ohms
17—100,000 ohms
1—180,000 ohms
1—200,000 ohms
1—220,000 ohms
1—330,000 ohms
1—1 megohm
2—1.5 megohms
1—2.0 megohms
1—3.3 megohms

Trimmer pots

31—50,000 ohms, MuRata type RVA0911H 306-7 503M
2—1000 ohms, MuRata type RVA0911H 306-7 102M
4—50,000 ohms, Weston type 8501

Slide pots

7—50,000 ohms linear, Alps type LD14R 50K B

Resistors ¼-watt, 1% or better

1—1000 ohms
1—3000 ohms
2—10,000 ohms
1—12,000 ohms
2—30,000 ohms
1—48,000 ohms
1—192,000 ohms
1—768,000 ohms

Capacitors

5—5-pF disc
4—10-pF disc
1—82-pF disc
3—100-pF disc
1—680-pF disc
9—0.001-μF disc
2—0.005-μF disc
7—0.01-μF disc
1—0.039-μF disc
3—0.1-μF disc
1—5-15-pF trimmer
1—7-40-pF trimmer
1—2.5-10-pF trimmer
2—100-400-pF trimmer

Electrolytic capacitors, 16 volts or higher

3—1 μF
1—2.2 μF
1—4.7 μF
1—22 μF
10—10 μF
3—33 μF
9—100 μF
1—470 μF
3—500 μF

Semiconductors

4—741 operational amplifier
4—748 operational amplifier
6—318 precision high-speed operational amplifier (Fairchild, National)
2—XR-2207 VLO (Exar)
1-TL610 analog switch and driver (Texas Instruments)
1—8048 logarithmic amplifier (Intersil)
1—8049 antilogarithmic amplifier (Intersil)
1—LH0091 true RMS-to-DC converter (National)
1—ULN2004 10-channel printer/driver (Sprague)
1—UDN2982 digit driver (Sprague)
1—4013 dual "D" flip-flop
1—MK50395 counter/display driver (Mostek)
1—4194 dual-tracking voltage regulator
2—7812 positive 12-volt regulator (TI, National, Motorola)
1—309H positive 5-volt regulator (Motorola, National, Signetics)
1—7912 negative 12-volt regulator (Fairchild, National, TI)
1—377 2-watt dual-channel audio amplifier (National)
1—74121 monostable multivibrator
1—4528 dual monostable multivibrator (TI, Fairchild)
1—14556 timebase generator (Motorola)
1—4030 or 4070 quad exclusive OR gate
9—TIS97 NPN silicon transistor
8—1N4001 diode
9—1N4148 diode
5—LED's
6—MAM-72 7-segment LED display
1—VP130A10 transient-suppressor varistor
2—LA10 overvoltage protector
2—LVC01A5.1 overvoltage protector
1—LA5.1 overvoltage protector

Miscellaneous

3—single-pole, 10-position rotary switch Alco MRB-1-10-PC
1—SPST toggle switch C & K 7101L1C
7—SPDT toggle switch C & K 7101SC
1—DPDT toggle switch C & K 7211SC
7—DPDT toggle switch C & K 7201SC
2—DP3T toggle switch C & K 7411SC
1—SP3T toggle switch
1—transformer, 24-volt secondary, Triad F45X
6—panel-mount BNC connectors
1—panel-mount 3-conductor microphone connector
6—fuse holders
3—250-volt ½-amp fuse
2—2-amp fuse
1—35-volt 15-amp fuse
1—PC board
1—cabinet
1—voltmeter with linear, log and dB scales.

Calibration

Most of the audio sweep circuitry is identical to the timebase section so the same calibration procedure applies. Output level and symmetry calibration proceeds from the output circuits back. That is, set R7 to zero and adjust R534 for zero DC level. Then set R7 to maximum (with switch S13 set to not-blank) and adjust the trimmers between oscillator IC502 and S14. The only difference in this area is that R513 must be adjusted, whereas its counterpart in the timebase was fixed. Interaction between R510 and R513 is rather subtle. It is not enough to adjust each independently for minimum distortion. Often by actually increasing the distortion with one of these pots subsequent adjustment of the other pot will result in lower distortion.

The optimum calibration procedure uses a harmonic distortion analyzer and a dual-trace scope. First, a sinewave is mathematically plotted on the face of the scope and the output of the function generator is adjusted so that the period and amplitude correspond to the peaks and zero-crossing points of the plotted sinewave. This same signal is simultaneously fed to the input of the distortion analyzer. The output of the distortion analyzer is applied to the second trace of the scope. The first adjustments are made with a screwdriver in each hand, and R510 and R513 are adjusted simultaneously to provide the best visual fit between the generator waveform and the plotted waveform. Observing the output of the distortion analyzer at the same time provides some understanding of the effect and interaction of these two controls. The final adjustment is made by the meter on the distortion analyzer. However, if there is a visual deviation between the generator waveform and the plotted waveform, this indicates that further improvement is possible.

A simpler but less precise test is to use only a single-trace oscilloscope with a sinewave plotted on its screen. This single waveform should cover as much of the CRT face as possible. (See Fig. 8) On most scopes this would be 8 × 8 centimeters. A visual match between the generated and plotted waveforms will produce distortion components that are low enough to be insignificant in frequency-response measurements.

Frequency sweep

The following procedure will calibrate the manual frequency sweep. This involves both the timebase and audio sweep

generator sections since both can provide a manual frequency sweep of the audio sweep generator. Recall that during the discussion of the timebase section, fine tuning of the manual timebase mode was set aside until a later time. That function will now be covered as well.

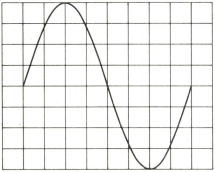


FIG. 8—SINE FUNCTION can be plotted on the CRT screen and used to adjust the sweep generator for minimum distortion.

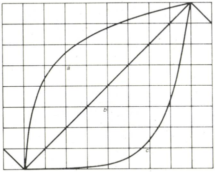


FIG. 9—CALIBRATION WAVEFORMS. Log function is shown in *a*, triangular wave is shown in *b* and antilog function is shown in *c*.

This procedure assumes that the frequency counter is already part of the overall system. It will provide the calibration standard for the sweep circuit because it measures the ultimate result of those circuits. Since it is voltage levels that are to be calibrated, the frequency counter can be thought of as a digital voltmeter.

Set S11 to manual

Sweep R6 thru its maximum travel.

Observe the end-point frequencies.

Adjust R502 and R503 for the desired end-points.

R503 sets the total sweep width.

R502 affects mainly the low-frequency end-point.

If a full 20-Hz to 20-kHz sweep is desired, the voltage at the output of IC501 goes slightly positive so as to cut off the current from pin 7 of oscillator IC502. This voltage will pass thru zero at approximately 30 Hz. With the output of IC501 at zero volts, check the symmetry of the oscillator by observing the triangle wave. This is a test that the manufacturer of the oscillator IC does not perform and, hence, a relatively large number of devices are significantly nonlinear at this point. The devices can be very linear at 20 Hz and at 40 Hz but quite nonlinear at 30 Hz.

Place a scope on the output of IC501.

Set the vertical amplifier for 1 volt-per-division and move the trace to one division from the top of the screen with no input.

Run R6 thru full travel and note the end-point voltage levels.

Set the timebase frequency for 1 kHz.

Set S4 to symmetrical.

Set S9 to SWEEP.

Set S12 to LINEAR and S11 to SWEEP.

There should now be a triangle wave that can readily be positioned and scaled, using R10 and R11, so that its peaks correspond to the end-point voltages that were produced by sweeping R6 thru its full travel.

Switch S12 to LOG.

Run R8 (the front-panel high-frequency log sweep set) to the end of its travel at maximum sweep width and then back off three turns.

Plot an antilog function as shown in Fig. 9-a on the face of the oscilloscope and align the generated waveform with that plot. (An 8 × 8-centimeter film overlay of log, antilog and sine functions is available from Fidelity Sound for $5.00). To provide a stable overlay of the plotted and generated waveforms, it is generally helpful to trigger the scope from the triangle output of the timebase generator. Use the manual trigger level rather than automatic. Also it is often helpful to switch S8 to INVERT. A dual-trace scope is also helpful here. The peak of the antilog function is easy to locate, the low point of the valley is not. If the triangle wave is adjusted on the scope as shown (Fig. 9-b), it establishes the end-points of the antilog function.

Adjust R401 and R403 so that the antilog waveform has approximately the same span as the R11 sweep voltage and has no clipping at the peak.

Use the variable vertical amplifier attenuator on the scope to scale the generated antilog waveform to that of the plotted antilog function.

Adjust R401 and R403 for best visual match between the plotted and generated waveforms. Note what effect each direction of each pot has on the generated waveform. This accomplishes the approximate adjustment of the antilog waveform. Final adjustment will occur later in this section.

At this point everything is at least approximately calibrated so that the timebase will sweep the audio generator either manually or automatically, and linear or logarithmic. The following will calibrate the manual sweep control:

Set S3 to 100 and R1 to its lowest position.

Set S4 on symmetrical.

Set S9 to SWEEP.

At this point we are going to use the audio sweep generator and the counter as a digital voltmeter. The sweep generator then acts as a voltage-to-frequency converter. This will be used to match the manual and sweep modes of the timebase.

Since the log sweep has the greatest resolution at low frequency and the linear sweep has the greatest resolution at high frequency, that is how they will be set.

Set the horizontal amplifier on the oscilloscope to external.

Apply the timebase triangle wave to the vertical and horizontal scope inputs simultaneously. If a line is traced from the lower left to the upper right, this indicates the positive voltage drives the horizontal amplifier in a right-hand direction. A line from upper left to lower right indicates that a positive voltage drives the horizontal amplifier in the left-hand direction. In this case switch S8 to INVERT so that there is a line traced from lower left to upper right. That way a response plot will have the low frequencies at the left and the high frequencies at the right.

Set R4 at zero.

Switch S3 to 10 Hz. Use R3 to establish a 10-centimeter sweep (it may be necessary to use horizontal-expand mode on scope).

Switch S3 to .002.

Set S22 to ½ second.

With the beam traveling to the right and the counter increasing in frequency and with S12 in linear, observe the end point of the beam and the highest frequency attained.

With the beam traveling toward the left side and the frequency of the audio sweep generator decreasing and (with S12 set to the LOG position), note the turn-around point of the beam and the lowest frequency reached by the audio sweep generator. It is possible to interpolate fractions of a Hz by observing the bobble of the counter between two frequencies. If, for instance, it bobbles between 20 and 21 Hz every time the counter refreshes, which is one-half second, then the frequency is 21.5 Hz. Or if it stays on one number longer than the other, then it is closer to the displayed number at which it stays the longest.

Repeat the slow sweep a couple of times to confirm the end-point frequencies. Remember to switch S12 when the trace switches directions.

Switch S9 to manual.

Turn R4 thru its full travel. The frequency of the audio sweep system generator should track the movement of R4.

Set S12 to LOG and R4 to its lowest position. Note the frequency of the audio generator.

Switch S12 to LINEAR and move R4 to its upper position. Note the frequency of the audio generator.

Adjust R206 and R209, in the timebase section, so that as R4 is moved thru its travel and S12 is switched, the same end-point frequencies are produced as were produced during the automatic sweep mode. Trimmer R209 establishes the total sweep width and R206 sets the

continued on page 113

Cassette Player For Metal Tape

A new recording tape composed of metal particles provides higher output, lower distortion and better S/N ratio. Here are details on a recorder that takes advantage of these and other improvements.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IN THE NOVEMBER 1978 ISSUE OF **RADIO-Electronics,** we discussed a new type of recording tape, variously described as "metalloy," "metal particle," or by the trade name assigned to one of its manufacturers (3M Company)—*Metafine*. We described how this tape can improve the dynamic range capabilities of both cassette and open-reel tape recordings, and suggested that at last, analog tape recording may not pose any of the limiting factors that it has in the past and that has prompted tape recording engineers to explore alternatives to analog recording such as digital or PCM recording.

We also discussed problems of compatibility that the new tape posed with respect to existing tape decks and tape heads. While we suggested that the tape-head problems have already been solved by several manufacturers, we did not touch on how tape recorder electronics can be modified to take the fullest advantage of the capabilities of the new metal-particle tape.

Two manufacturing approaches

Recently we had an opportunity to interview representatives from two tape-equipment manufacturers who have done something about the potential problems that may be created when the new metal-particle tape becomes commercially available. The companies are Tandberg (of Oslo, Norway) and Nakamichi Research of Japan.

Tandberg recently announced that they would soon have available a stereo cassette deck, the *model TCD-340AM,* that would be compatible with 3M's *Metafine* tape. We have also learned that other Tandberg cassette and open-reel models, although not specifically equipped to handle this tape, use a new recording system (in their electronics) that Tandberg calls "Actilinear," and on which patents are pending. The two models already using this recording system are the *model TD 20-A*, a 10½-inch two-speed open-reel tape recorder and the *model TCD-340-A*, a three-motor, three-head cassette system shown in Fig. 1.

Tandberg claims that the Actilinear recording system, as incorporated in the open-reel *model TD-20-A*, offers a 20-dB improvement in headroom over conventional record amplifiers. In addition to this advantage (which, in itself, means a greater dynamic range providing the tape can handle the increased recording level), the following advantages are cited:

1. Less intermodulation caused by slew-rate limitations.
2. Less interference with the audio signal from the high-frequency bias and erase oscillator.
3. Substantially greater possibilities of adjusting the recorder to higher coercivity tapes, such as the new metal-particle tape.

How Actilinear works

In conventional systems, the recording-signal current and bias current are summed in the recording head by passive components such as a resistor, as shown in Fig. 2. This however leads to such difficulties as small headroom margin, slew-rate limitations for strong signals

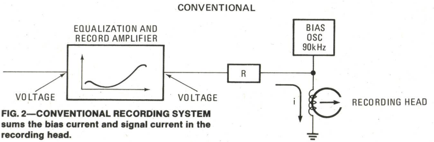


FIG. 2—CONVENTIONAL RECORDING SYSTEM sums the bias current and signal current in the recording head.

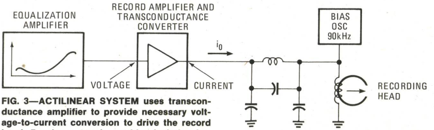


FIG. 3—ACTILINEAR SYSTEM uses transconductance amplifier to provide necessary voltage-to-current conversion to drive the record head. Passive network provides isolation between bias oscillator and record amplifier.

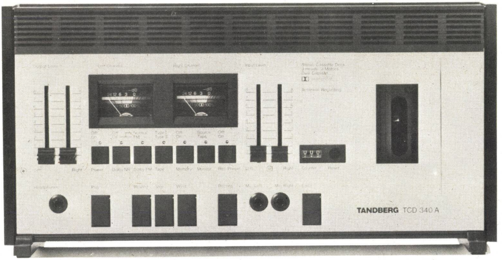


FIG. 1—TANDBERG MODEL TCD-340A stereo cassette deck with *Actilinear* recording system is capable of handling new metal particle tape.

and high frequencies, poor isolation between the oscillator and the recording amplifier, which, in turn, leads to those familiar beats when high frequencies are recorded with a low available margin in bias and recording currents.

The Tandberg Actilinear system consists of separate modules for record equalization and a transconductance module that provides the necessary voltage-to-current conversion to drive the heads (see Fig. 3). In addition, a filter circuit helps prevent bias current from mixing with the signal current. This results in reduced interference or beat-tones. The recording amplifier can work at lower signal levels and therefore produces less intermodulation caused by slew-rate limiting.

Figure 4 shows the Actilinear system in more detail. In the equalizer module, capacitor C2 and resistor R4 provide proper low-frequency record equalization, while components R2, R3, C1 and L1 provide the desired equalization from mid-frequencies upwards. The transconductance module has two main functions: It converts a voltage from potentiometer R5 to a current (i_s) that is the required recording current. It also provides isolation between the oscillator and the recording amplifier.

The transconductance circuit consists of two transistors—Q1 and Q2. Transistor Q1 is in a common-emitter design and has as its collector load, R9 and Q2. The collector appears as a low resistance to DC but as a high impedance to AC signals. The two collectors are connected at point P, which is at 12 volts DC, but can swing between 2 volts and 22 volts, and thus its high dynamic range is available to drive current i_s through the record head. The DC current through Q1 and Q2 is about 10 mA, so that each transistor represents an equivalent resistance of 1.2K at DC. The output impedance for AC, however, is 20K ohms for each transistor so that the total output impedance seen at point P is approximately 5K ohms. Since the recording-head impedance is much lower than 5K ohms, the circuit acts as a current source. A constant voltage at the input results in a constant current at the output and through the recording head.

The filter module is a low-pass circuit with a trap tuned to the bias frequency of 123.5 kHz. This circuit prevents bias oscillator signals at point R from entering or returning to point P. While the oscillator output voltage at point R is approximately 20, it is reduced to around 50 mV at point P.

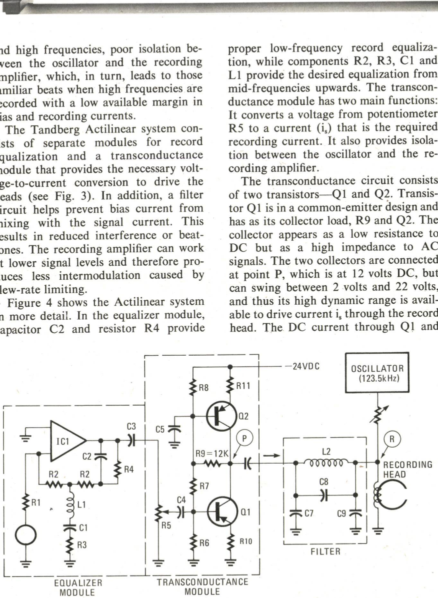


FIG. 4—SIMPLIFIED SCHEMATIC of the *Actilinear* recording circuit.

New Nakamichi technology

Nakamichi Research, Inc., has also been investigating the problems and the promise of metal-alloy tapes. In one of two prototype stereo cassette decks recently demonstrated (the Nakamichi model number tentatively assigned is "1000 II 'ZX' ") newly designed heads are used. A subminiature *Crystalloy* head that can handle the additional bias current of metal-alloy tape is used as the record head. A unique double-gap erase head is also used, plus a 0.8-micron *Crystalloy* playback head.

Figure 5 compares the frequency response and headroom characteristics between Nakamichi's SX tape (a treated-ferric low-noise high-energy tape) and the company's ZX tape (a prototype of a metal-alloy tape tentatively to be marketed under the Nakamichi brand name, ZX). The ZX tape was recorded (on the

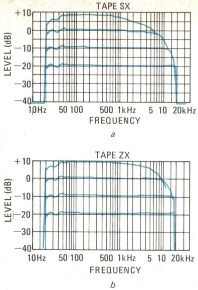


FIG. 5—FREQUENCY RESPONSE of Nakamichi's type SX treated-ferric tape (shown in *a*) and their prototype ZX metal-alloy tape (shown in *b*).

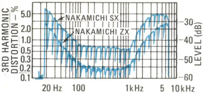


FIG. 6—HARMONIC DISTORTION comparison between Nakamichi's type SX ferric and type ZX metal-particle tapes.

TABLE 1—TOTAL DYNAMIC RANGE* (dB) comparisons

Frequency (Hz)	SX/Dolby	ZX/Telefunken	Improvement
1K	80	89	9
2K	78	91	13
3K	77	91	14
5K	74	86	12
10K	68	77	11
12K	61	76	15
15K	55	70	15
20K	46	63	17

*Total dynamic range refers to the difference in dB between the maximum output level and the noise floor at the specified frequency.

prototype machine) with 3-dB more bias than the conventional SX tape. Playback equalization was the same for both tapes, specifically, 3180/70 μs, and appropriate modifications in the record equalization were made for the ZX tape.

Figure 6 shows the low-distortion characteristic of the ZX tape when it is used with a record head that can provide the required high bias.

Compatibility problems

To avoid creating chaos in the metal-tape market, Nakamichi also suggested that tape manufacturers consider offering a broad-bias version of metalloy tape. This tape should be capable of being used in current cassette decks set to the chrome-tape position as well as in future tape decks with the additional bias-current capability. Currently available tape decks would still require new erase heads in order to make full use of this broad-bias tape. The company has designated this broad bias tape as ZX/BB and believes that it may well bridge the gap between the great potential of the new tape formulation and the current state of cassette hardware.

Noise-reduction system

Nakamichi has also proposed that a new noise-reduction system be introduced at this time. Back in 1970, Dolby became popular in home cassette machines at just about the time that the then-new "chrome" tapes were introduced, requiring a major redesign of cassette hardware.

Nakamichi now believes that the next major step for the cassette format depends upon the combined impact of a new magnetic tape and head technology plus an improved noise-reduction system. To achieve this, the company has selected and been involved with a consumer version of Telefunken's noise-reduction system, the professional version of which is known in Europe as *Telcom C4D*. The Nakamichi version, like most tape noise-reduction systems, is basically a compressor/expander that uses an encode process during record and a decode process during playback. Nakamichi feels that this system satisfies three important criteria: Full complementary action of the compressor and expander under steady-state and dynamic conditions; a circuit design featuring high repeatability and therefore compatibility from unit to unit; and, finally, suppression of the "breathing" noise that is often caused by modulation of tape noise by the recorded signal during expansion.

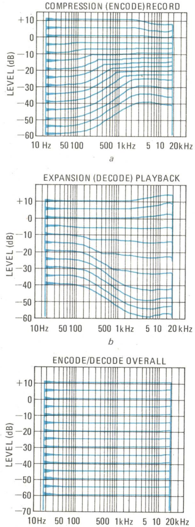


FIG. 7—THE TELEFUNKEN NOISE-REDUCTION compression, expansion and encode/decode curves—a, b and c, respectively.

The Telefunken system is similar to Dolby-B systems in that it works only on the upper end of the frequency scale. It differs from Dolby because it has a faster attack time and uses a 2:1 compression and expansion ratio. The system can provide a 20-dB improvement in signal-to-noise ratio (as compared with the 10-dB afforded by Dolby-B systems).

Figure 7 shows the Telefunken noise-reduction system's encode, decode and overall amplitude characteristics at various signal levels. As is true of the Dolby system, the Telefunken processor depends upon the accurate matching of record and playback reference levels. If, however, such level calibrations are accurately made, the overall record/playback response should be as error-free as shown in Fig. 7.

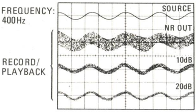


FIG. 8—COMPARISON between source and record/playback signal with none, 10 dB and 20 dB of noise reduction.

In the interest of providing compatibility, when Nakamichi installed this noise-reduction system in their prototype *model 1000 II ZX* cassette deck, a selector switch was also incorporated to provide a choice of either 10-dB or 20-dB noise reduction. The company believes the 10-dB position is compatible with existing Dolby-B systems. With a 10-dB position, a user could play back Dolby-encoded cassettes or record cassettes that could

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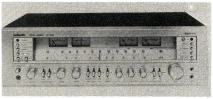
R.E.A.L.

Radio-Electronics Audio Lab Tests



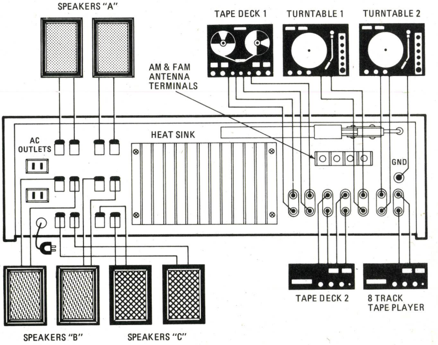
1

Lafayette LR-120DB Stereo Receiver

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WE RARELY TEST AND REPORT ON SO-CALLED private label audio equipment simply because past performance of many such nonbrand items has been disappointing. However, the Lafayette *model LR-120DB* is an exception. This unit outperformed many similarly priced receivers produced by well-known stereo component manufacturers and is extremely well built. It has just about every control feature you would want in a top-grade receiver. In addition, the fact that Lafayette stores are located throughout the country and their merchandise can be purchased from a mail-order catalog led us to do a full test report on this receiver.

Figure 1 shows the *model LR-120DB* has a large, easy-to-read dial area containing a well-calibrated linear FM dial scale and a conveniently arranged AM frequency scale. Located above the frequency scales on the left are signal-strength and center-of-channel tuning meters, and on the right a pair of power-output meters calibrated to 240 watts. A row of small pushbuttons and indicators to the left of the dial handle the Dolby FM mode (a Dolby decoder as well as 25-μs FM de-emphasis are included), a high-blend circuit for weak-signal stereo FM reception, a mono/stereo mode switch, FM muting with an associated muting-threshold control that varies the signal strength required to overcome muting, and a stereo indicator light.



2

MANUFACTURER'S PUBLISHED SPECIFICATONS:

FM TUNER SECTION:
Usable Sensitivity: mono, 1.8 μV (10.3 dBf); stereo, 4.0 μV (17.2 dBf). **50-dB Quieting:** mono, 2.8 μV (14.1 dBf); stereo, 38 μV (36.8 dBf). **Selectivity:** 80 dB. **Capture Ratio:** 1.3 dB. **IF Rejection:** 85 dB. **Image Rejection:** 80 dB. **Spurious Rejection:** 90 dB. **AM Rejection:** 55 dB. **S/N Ratio:** mono, 74 dB; stereo, 70 dB (10-dB more with Dolby). **Distortion at 1 kHz:** mono, 0.15%; stereo, 0.3%. **Mute Range:** 10 μV to 200 μV (25.2 to 51.2 dBf). **Frequency Response:** 30 Hz to 15 kHz, +0.5, −1.5 dB. **Stereo Separation:** 45 dB at 100 Hz and 1.0 kHz; 35 dB at 10 kHz.

AM TUNER SECTION:
Sensitivity: 20 μV. **Image Rejection:** 75 dB. **Selectivity:** 32 dB. **S/N Ratio:** 52 dB.

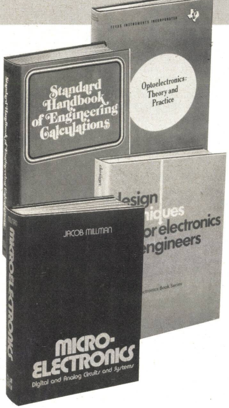
AMPLIFIER SECTION:
Power Output: 120 watts-per-channel into 8 ohms, 20 Hz to 20 kHz. **Rated Distortion:** 0.09%. **Input Sensitivity:** phono, 2.5/5.0/10 mV; high level, 150 mV; microphone, 5 mV. **Phono Overload:** 150/300/600 mV. **S/N Ratio:** phono, 70 dB; high level, 90 dB, "A"-weighted. **Bass Range:** ±12 dB at 50 or 100 Hz. **Treble Range:** ±10 dB at 10 or 20 kHz. **Midrange Control:** ±6 dB at 1 kHz. **Low-Filter Cutoff:** −3 dB at 15 or 70 Hz. **High-Filter Cutoff:** −3 dB at 7 or 12 kHz. **Low Boost:** +12 dB at 50 Hz; +10 dB at 100 Hz. **Audio Muting:** −15 dB or −30 dB.

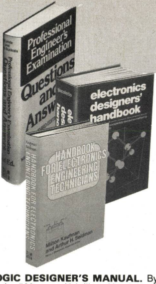
GENERAL SPECIFICATIONS:
Power Requirements: 105 to 120 volts, 50 to 60 Hz, 475 watts maximum. **Dimensions:** 21½ W × 7 H × 17⅞ inches D. **Net Weight:** 41 lb., 14 oz. **Suggested Retail Price:** $650.

To the right of the dial area are speaker-selector switches (for up to two sets of speakers), a remote speaker system selector switch, a meter range pushbutton (this control increases meter sensitivity so that full-scale readings correspond to 24 watts instead of 240 watts), and a main POWER on/off switch with an indicator light.

The remaining controls are arranged along the lower section of the panel. These controls include a microphone input jack with a mike mixing-level control; a program selector switch; two tape monitor and dubbing lever switches with settings for up to two tape decks; a balance control; a master volume control; bass, midrange and treble controls; a large flywheel-coupled tuning knob; and twin stereo phone jacks. Additional lever-type controls select either of two turnover frequencies for the bass and treble controls as well as defeating or bypassing these control circuits entirely. The bass-control turnover frequencies are either 500 Hz or 250 Hz; while the treble-

A new introductory Electronics





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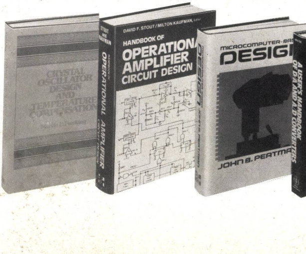

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control frequencies are 2.5 kHz or 5 kHz. A loudness-control lever switch offers a fixed degree of bass boost that is independent of the master volume control setting as well as the usual loudness compensation, and a two-position muting switch provides either 15 dB or 30 dB of fixed signal attenuation.

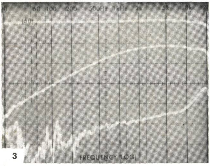
The rear panel (see Fig. 2) of the *model LR-120DB* contains input- and output-connection terminals separated by heavy heat-sink structures. On the left-hand side are three sets of spring-loaded speaker terminals and a pair of AC convenience outlets (one switched, the other unswitched). The antenna terminals (also on the left) permit connecting AM, 300-ohm and 75-ohm FM antennas. An attenuator switch alongside these terminals reduces signal strength in case of tuner overload. Also provided are two pairs of phono input jacks, auxiliary and recording input jacks, and two pairs of tape-output jacks. A three-position slide switch alters the phono-input sensitivity and lets you choose either a 2.5 mV, 5.0 mV or 10 mV input level for rated output. In addition, a chassis ground terminal and a pivotable AM ferrite-bar antenna are provided. Figure 2 shows the various types of equipment that can be connected to this receiver.

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lafayette Radio** — Model: **LR-120DB**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono (μV) (dBf)	1.7 (9.8)	Excellent
Sensitivity, stereo (μV) (dBf)	3.2 (15.3)	Excellent
50-dB quieting signal, mono (μV) (dBf)	2.7 (13.8)	Excellent
50-dB quieting signal, stereo (μV) (dBf)	31.0 (35.0)	Excellent
Maximum S/N ratio, mono (dB)	75	Very good
Maximum S/N ratio, stereo (dB)	70	Very good
Capture ratio (dB)	1.3	Good
AM suppression (dB)	56	Very good
Image rejection (dB)	83	Very good
IF rejection (dB)	85	Very good
Spurious rejection (dB)	92	Excellent
Alternate channel selectivity (dB)	80	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	1.2	Good
Harmonic distortion, 1 kHz, mono (%)	0.12	Very good
Harmonic distortion, 1 kHz, stereo (%)	0.20	Good
Harmonic distortion, 100 Hz, mono (%)	0.15	Very good
Harmonic distortion, 100 Hz, stereo (%)	0.12	Excellent
Harmonic distortion, 6 kHz, mono (%)	0.13	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.25	Excellent
Distortion at 50-dB quieting, mono (%)	0.47	Very good
Distortion at 50-dB quieting, stereo (%)	0.3	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	2.0 (11.2)	Excellent
Separation, 1 kHz (dB)	50	Excellent
Separation, 100 Hz (dB)	56	Superb
Separation, 10 kHz (dB)	41	Excellent
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	10–150 (25.2–48.7)	Very good
Dial calibration accuracy (±kHz at MHz)	100	Very good
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Very good
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Very good
Construction and internal layout		Excellent
Ease of servicing		Very good
Evaluation of extra features, if any		Excellent
OVERALL FM PERFORMANCE RATING		Excellent



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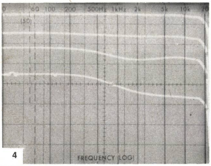

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Circuit highlights

Although a complete schematic diagram of the *model LR-120DB* was not available, certain features and circuit designs are described in the owner's manual. A dual-gate MOSFET is used in the RF amplifier of the FM front end, along with a four-section variable tuning capacitor. Two 2-element ceramic filters and a 6-pole linear-phase L–C filter are used in the IF section. A single special IC functions as an IF amplifier, a quadrature FM detector circuit, and a driver circuit for the tuning meters, as well as providing muting that can eliminate inter-station noise and mute sounds when the tuner is not properly set to center-channel. The power amplifier section uses direct-coupled (output capacitorless) output stages that are protected by dual relay and electronic-overload circuitry.

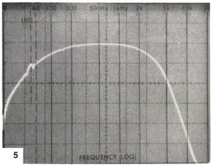
FM measurements

Table 1 summarizes our FM performance measurements. In comparing test results with published specifications, we noted that virtually every specification was either met or exceeded substantially.

Figure 3 is a scope photo of FM frequency response (upper trace), normal stereo separation (lower trace), and stereo FM separation when the multiplex blend filter is introduced. In Fig. 3 and in all scope photos in this report, frequency is plotted along the horizontal axis (from 20 Hz to 20 kHz) while relative amplitude is shown vertically, with each major division equal to a 10-dB amplitude change.

Figure 4 shows the built-in Dolby FM decoder response. As required in Dolby broadcasting, the de-emphasis is changed automatically to 25 μs and, at 100% modulation levels, the response curve is flat (upper trace). As modulation levels are decreased (corresponding to quieter musical moments), high-frequency response is successively rolled off in increasing amounts (lower traces), restoring flat overall response, since those high frequencies had been correspondingly preboosted at the broadcast station. The overall effect is that there is a significant noise reduction at every level without any sacrifice of flat response.

As for the AM section, published specifications were generally met, with 50-dB signal-to-noise ratios observed for strong input signals. However, as typical of most hi-fi stereo receivers, frequency response was not included in the published specifications. The AM frequency response curve of Fig. 5 shows why:



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Response was already rolling off at 2 kHz.

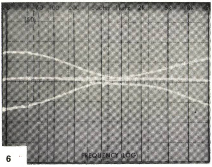
Amplifier measurements

Table 2 summarizes the measured performance of the receiver's power amplifier and preamplifier/control sections. Lafayette could easily have claimed a +140-watt power rating, instead of the conservative 120 watt-per-channel rating they assigned. Furthermore, the power bandwidth of the amplifier (frequency extremes at which rated power was still available at or below rated harmonic distortion) was extremely wide—from below 10 Hz to 50 kHz. Considering that this receiver does not use a DC-configured power amplifier, these results are quite outstanding.

Figure 6 shows the range of bass and treble controls when 500-Hz and 2.5-kHz turnover frequencies are selected. However, when the alternate turnover frequencies are chosen (see

Fig. 7), it becomes possible to boost or cut extreme bass or treble frequencies without affecting the musical midrange tones. This form of tone-control adjustment proves to be more useful in most stereo systems than the broader adjustment range. Figure 7 also shows the action of the midrange tone control whose maximum boost or attenuation frequency is exactly 1 kHz, as claimed.

Figure 8 shows the response of the two-position high-cut filter and that of the low-cut filter. Attenuation slopes are all 12 dB-per-octave; the attenuation of the subsonic (15-Hz) setting of the low-cut filter could not be shown since it begins at a frequency below the 20-Hz lower limit of our spectrum analyzer. In



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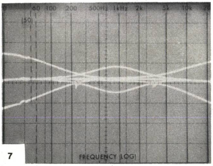

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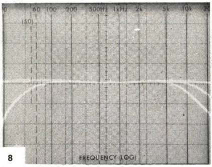

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listening tests, however, the 15-Hz setting provided audible improvement when used with a turntable having subsonic rumble.

Summary

Table 3 contains our overall product analysis, along with summary comments. We believe there would seldom (if ever) be a need for a higher-powered receiver in a home music system than can be provided by the *model LR-120DB*. The receiver (unlike many) is Underwriters' Laboratory (UL) listed for safety. In their latest mail-order catalog, Lafayette lists the *model LR-120DB* as "the finest receiver we've ever offered," and we agree. The unit also carries a two-year warranty, which is somewhat unusual for an electronic audio instrument. Best of all, the cost of this receiver is remarkably low. **R-E**

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lafayette Radio** Model: **LR-120DB**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	159.0	**Superb**
RMS power/channel, 8-ohms, 20 Hz (watts)	150.0	**Superb**
RMS power/channel, 8-ohms, 20 kHz (watts)	144.0	**Excellent**
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	**N/A**
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	**N/A**
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	**N/A**
Frequency limits for rated output (Hz-kHz)	10–50	**Superb**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.055	**Superb**
Intermodulation distortion, rated output (%)	0.11	**Very good**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.055	**Very good**
Intermodulation distortion at 1-watt output (%)	0.03	**Excellent**
DAMPING FACTOR, AT 8 OHMS	41	**Good**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±dB)	0.2	**Excellent**
Maximum input before overlaod (mV)	220/400/780	**Superb**
Hum/noise referred to full output (dB) (at rated input sensitivity)	75	**Very good**
HIGH-LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±dB)	15–40, 1.0	**Excellent**
Hum/noise referred to full output (dB)	90	**Excellent**
Residual hum/noise (minimum volume) (dB)	94	**Good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Figs. 7&8	**Excellent**
Action of secondary tone controls	See Fig. 8	**Excellent**
Action of low-frequency filter(s)	See Fig. 9	**Excellent**
Action of high-frequency filter(s)	See Fig. 9	**Excellent**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/5.0/10.0	
Input sensitivity, auxiliary input(s) (mV)	150	
Input sensitivity, tape input(s) (mV)	150	
Output level, tape output(s) (mV)	150	
Output level, headphone jack(s) (V or mW)	120 mW	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Excellent**
Adequacy of input facilities		**Excellent**
Arrangement of controls (panel layout)		**Very good**
Action of controls and switches		**Excellent**
Design and construction		**Very good**
Ease of servicing		**Very good**
OVERALL AMPLIFIER PERFORMANCE RATING		**Excellent**

TABLE 3

OVERALL PRODUCT ANALYSIS

Retail price	**$650**
Price category	**Medium/high**
Price/performance ratio	**Superb**
Styling and appearance	**Very good**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

Comments: The Lafayette Radio *model LR-120DB* stereo receiver is one of the best values in a high-fidelity component we have ever tested. This is all the more remarkable since our experience with other so-called private label audio products has often been disappointing. Traditionally, the serious audiophile has looked down upon such non-branded equipment as being inferior to that made by the better-known domestic and foreign manufacturers. While we do not know which Japanese manufacturer designed and built this receiver, it probably was one of the better companies that also produce their own identified line of receivers. FM reception, and particularly stereo FM, was superb, using our standard outdoor five-element antenna. We logged nearly 55 usable signals in our metropolitan New York testing area. Interstation muting is positive and precise, and the threshold is narrow enough to allow even the weaker signals through while still taking advantage of the noise-free tuning feature.

As for the amplifier, power output is extremely conservatively rated and power bandwidth extends well beyond hearing limits. The selectable phono sensitivity is a welcome feature, both for matching phono levels to other program sources and in providing enormous headroom for high-output cartridges. The 10-mV input setting, however, is a bit of overkill and not really required with any cartridge we know. Selectable tone-control turnover plus a midrange control are features you might find in a receiver costing much more. Audio reproduction was tight and well balanced at all listening levels. The Dolby decoding circuitry for Dolby FM adds greatly to the actual worth of the receiver and was precisely calibrated.

This receiver deserves extremely high ratings in terms of price and performance.

HOBBY CORNER

Here's a look at four different ways of making prototype printed-circuit boards. **EARL "DOC" SAVAGE, K4SDS,** HOBBY EDITOR

BEFORE GETTING TO THE MAIN TOPIC FOR this month, I am again reminded that the world can sometimes run away and leave you behind. I do suppose, though, that I am not back here all by myself. If you are also trying to figure out just what a microcomputer is, what it can do for you and what the different characteristics mean, a new *free* publication can help you out:

Radio Shack's new *TRS-80 Microcomputer Catalog No. RSC-2* is actually more a source of general information than a catalog. It did clear up several points for me—perhaps it will do the same for you. You can pick one up at your local Radio Shack store.

More PC prototyping systems

By this time you know that I am a strong advocate of "the easy way" in doing anything and everything. On the subject of IC and transistor projects, that is why I have always recommended using the pencil-wiring system. This technique on plain perforated boards or *universal* PC boards is hard to beat. For instance, when you are going to build only one or two similar boards, pencil-wiring is faster, easier and/or less costly than laying out a dedicated PC board.

Yet there are times when a dedicated (especially made for a particular circuit) board is desirable or even necessary. For example, this is the way to go if a circuit must undergo vibration or rough handling. This means getting the circuit down on the board with few, if any, wires. There are several photosensitive and transfer systems for making dedicated PC boards. You should use one of them if you plan to make multiple copies of the same board. However, this is a lot of work for prototyping, making one or two copies of a board.

In my never-ending search for the easy way, I have discovered several methods to accommodate my laziness and still make good dedicated PC boards on a prototype basis. Because each of these methods has its own advantages, I'll tell you about them and then you can choose the one(s) that meets your needs. First, however, there is a task that you must perform regardless of the method you use.

Only if you are copying a preplanned circuit from a magazine or handbook can you get by without planning your layout. Laying out your PC board can be simple or extremely difficult depending upon the circuit, but starting the PC board without such planning is pure folly. The idea, of course, is to have a minimum number of crossovers (jumpers) and adequate space for all components—all in the minimum size PC board.

You may have to draw and redraw the circuit several times. The time spent designing a good layout is certainly worthwhile. When (and *only* when) you have created a satisfactory pattern, are you ready to make the board. We'll now look at four different so-called "fast" systems for making prototype PC boards.

Cut-'N'-Peel method

The Circuit-Stik Division of Bishop Graphics produces a neat prototyping system called *Cut-'N'-Peel.* All you do is draw your circuit pattern on a special board, cut through the copper foil with a razor knife, and peel away the unwanted copper. You now have a dedicated PC board ready to use. The process is almost as simple as it sounds—just be careful to prevent the knife from slipping (although you can repair the foil if you do cut too far), and you do have to drill the holes *if* you choose one of the plain boards to start.

The *Cut-'N'-Peel* PC boards are available in a number of sizes both with and without edge-connector contacts. The boards come plain or drilled with the standard DIP spacing and with copper coating on one or both sides. Altogether there is a wide variety of types to meet any need. For further information, circle number 147 on the Free Information Card in the back or write Circuit-Stik Division of Bishop Graphics, Inc., P.O. Box 5007, Westlake Village, CA 91359.

Circuit-Stik method

The very name of this outfit comes from an "instant circuit board" system. In this system, you literally "stick" a circuit together on an unclad plain or drilled board. There are many subelements included, such as socket patterns of all shapes and sizes for discrete components and IC's, component strips, "donut" pads, connector patterns, and many others.

Making a dedicated PC board requires just a few simple steps: Draw the circuit pattern on an unclad board, select the necessary subelements and stick them on the board; drill for components (if using an undrilled board), mount the components and solder. The subelements can even be repositioned if you happen to put them in the wrong place.

One very nice feature of this *Circuit-Stik* system is that you *can* have crossovers in the foil pattern. Just place some insulation over a trace, then you can run another foil strip across it.

This system is very convenient for making quick prototype boards although you may find it more costly to get started than some other methods. Further information is available from Bishop Graphics.

Drill-mills

Another etch*less* system for making PC boards comes from A. F. Stahler Company. This method uses "drill-mills" that are made in several sizes and types.

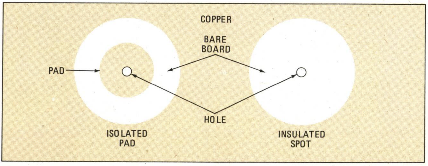


FIG. 1

These devices fit into a drill just like a regular drill bit, but they drill a small hole through a plated board and, *at the same time,* mill the copper surface plated on the board.

One type of drill-mill produces an isolated pad (see Fig. 1) and the other, an insulated spot. The isolated-pad drill-mill is used when the component lead is to be soldered as it passes through the board. With the small bit removed, this same tool can make isolated solder pads without a center hole. The latter process is difficult to do without a drill press or a stand for your hand drill (which is also the best way to use drill-mills in any case). If the component lead is *not* going to be attached to the board (as in wire-wrapping, for example) the insulated-spot drill-mill is used.

The smallest drill-mill is suitable for the 0.01-inch spacing required to make the pads for IC sockets. There is a choice of bit sizes, and of pad and spot sizes, plus a rubber stamp is available for stamping IC-socket drilling templates on the PC board.

Boards made with Stahler drill-mills have several differences. Components are mounted on the copper side of the board and leads are soldered to the isolated pads. Most of the wiring is done on the unclad side of the board using the lead tails themselves. This produces a beautiful ground plane, of course, and the parts are solidly fastened. That ground plane can be especially advantageous in creating radio-frequency circuits as well as some digital and linear circuits.

Full details on use, sizes and prices of the drill-mills are available from A. F. Stahler Company, P.O. Box 354, Cupertino, CA 95014.

Stamp-Etch system

The fourth "easy-way" dedicated printed-circuit board system requires etching, but it is probably the fastest and simplest method to prepare a blank board for the etching process. All you do is to stamp and draw the circuit pattern on the board; the secret to the ease of using this system lies in the stamping.

Freehand drawing with a "resist pen" would work by itself if it were not for the transistor, IC and connector patterns. (Have you ever tried to draw an IC socket accurately on a 1:1 scale?) Fortunately, there is a better way. Now you can actually stamp the socket patterns (and others) right on the copper using a special etch-resistant ink pad, then draw just the interconnecting lines, and you are ready to etch. It's that simple!

Rainbow Industries (P.O. Box 2366, Indianapolis, IN 46206) produces rubber stamps in many different patterns. They are used just like ordinary name and address stamps, except that you use special etch-resistant ink and take a little extra care during stamping.

This *Stamp It-Etch It* system really fills the bill for one- or two-of-a-kind dedicated PC boards. Stamp, stamp, draw the lines and then etch. What could be quicker?

Of course, you can use the stamps on paper as well as on copper-clad boards. This means that you can save time in planning layouts. No more socket-pattern sketching—you just stamp your patterns. If the first (or second or third) layout doesn't work well, just stamp another. In addition, if you plan to make multiple boards with a photographic process, you can use the stamps to make the original master pattern.

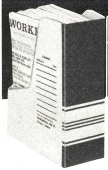
When planning layouts on paper, use a regular stamp pad. For photographic originals, however, the ink in most pads is not thick enough for a solid impression. For better results, use Rainbow Industries' resist-ink pad and a nonabsorbent paper.

Rainbow's *Stamp It-Etch It* system is altogether quite versatile. Several kits as well as individual stamps are available. If you follow the instructions provided, you will get good results. Pay particular attention to two instructions: keep the stamps clean and use a light impression.

Summary

There you have the gist of four easy

continued on page 97



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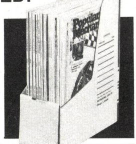

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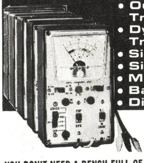

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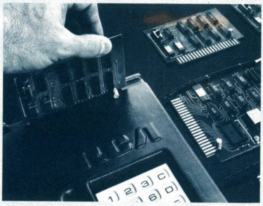

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The fun way into computers.

RCA

continued from page 95

ways to make dedicated printed-circuit boards when you need them. Each system will make good, serviceable boards. Only one of the four systems actually requires etching a blank board.

Producing a PC board using any one of the systems described in this column is much less expensive than having someone else make it for you. The only less costly PC board is one ordered from someone who spreads the cost over a large number of boards. Of course, such boards are available for only a few specialized circuits.

As far as the relative cost of each system is concerned, it is difficult to gauge. The *Cut-'N'-Peel* system is probably the least expensive alternative for creating only one or two boards. The cost-per-board for the other three methods decreases rapidly as you produce more (different) boards. The *Stamp It-Etch It* system involves the mess of etching, but gets the circuit on the board more quickly. The drill-mills require more actual wiring than the other methods, but no more supplies are needed unless you break the drill bit. The *Circuit-Stik* method allows you to make changes on the board and permits crossovers. So, take your pick—to each person, his own brand of poison!

As mentioned earlier, any and every PC board system requires layout planning as the first step. If, like me, you don't make many PC boards and, therefore, have to make a number of trial layouts, using those Rainbow stamps to plan layouts saves considerable time. Even if you use another PC board method to make your dedicated boards, consider the pattern stamps just for layouts. Several stamps and different-colored pens or pencils will make your efforts much less confusing and speed up the whole process significantly.

We have had space only to hit the high spots of these systems. Write the manufacturers for more detailed information and prices.

In winding up this discussion of prototype boards, I can't resist saying that I still prefer pencil-wiring printed-circuit boards unless the specific circuit or application considerations require a dedicated printed-circuit board! **R-E**

If you would like more information on any of the printed-circuit board prototyping systems mentioned, you can obtain it by circling the appropriate numbers on the Free Information Card in the back of this issue.

Bishop Graphics—**Circle Number 147**

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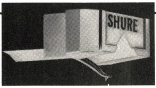

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Switching supplies are tricky, but you have to know how to handle these circuits. More and more of them are turning up in recent models.

JACK DARR, SERVICE EDITOR

LET'S TAKE A LOOK AT ANOTHER PULSE-width-modulated DC power supply that has been around since 1972. It's the Quasar electronic DC power supply used in their TS938 and other chassis. Its full name is "High-Frequency Electronic-Switched Pulse-Width-Modulated DC Power Supply," but we'll refer to it as the JA panel.

Compared to other power supplies, this one is simple and not difficult to service using the right methods. It runs at 15,750 Hz, synchronized to the horizontal oscillator. The power transformer is a "fly-back" unit, in which the primary current is switched by a power transistor. The secondary voltages supply all the DC power, even the picture-tube heater. This means the chassis is completely isolated from the AC line.

The switch is controlled by driver transistors and pulse shapers; plus it has its own 15,750-Hz oscillator. Because this is a blocking oscillator, it free-wheels; a "starter" circuit for the horizontal oscillator on the set is not necessary. After the horizontal oscillator starts, it syncs the free-wheeling oscillator. All the drivers, etc., on the JA panel are also completely isolated from the AC line. In fact, these circuits have their own "isolated ground," which is on terminal 7 of the JA panel (Fig. 1). All DC voltages and waveforms here *must* be measured to this isolated ground; all chassis DC voltages and waveforms are read to chassis ground. This is important to remember!

The DC voltage is regulated with a pulse-width modulator. A voltage sample from a tertiary winding (terminals 3 and 12) on the power transformer is rectified and used as a control voltage for the regulator stage. Under a heavier load, this voltage drops, so the regulator circuit widens the drive pulse to deliver more energy and bring it back up. The oscillator develops a pulse that is shaped and controlled by the regulator and a pulse-shaper stage. This is a squarewave, feeding a driver stage that controls the switching transistor.

The high-voltage shutdown used in all solid-state sets is as follows: An SCR is connected across the drive circuit of the switching transistor whose gate senses the emitter voltage of the switch transistor. If something happens to make the switch

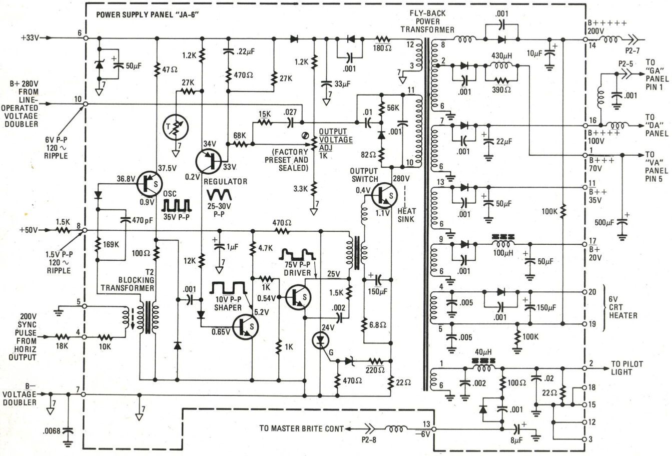

FIG. 1

transistor conduct too heavily (thus raising the voltage), the emitter voltage rises, the SCR fires and shunts the drive. The switch is turned off; because an SCR stays on until its anode voltage is cut off, the set must be turned off to reset the SCR.

Figure 1 is a diagram of the JA panel. The basic power supply for this (not shown) is a voltage doubler on the chassis. Note the isolated-ground symbol, the hollow triangle, on terminal 7; the key waveforms for the oscillator, shaper and driver stage. Note in particular the clean squarewave pulse on the collector of the pulse shaper. If this key waveform lacks amplitude or is rounded or distorted, watch out! The actual drive pulse on the driver is rounded; this may be due to the inductive loading of the transformer. These were taken from a working JA panel on our bench, and confirmed by the factory in the TS938 manual!

The first test for this circuit is with the seven DC voltage outputs, including the pilot lights. If one pilot light is out, check its rectifier diode. If this diode is bad, replace it only with a fast-recovery type, because ordinary "sinewave" diodes won't do. Incidentally, if the pilot light is burning, this means that at least one of the panel's secondary supplies is OK.

If none of these voltages are present or if they're off, make sure that the blocking oscillator is running at the proper frequency. Use your scope for these tests. Follow the waveforms through the pulse shaper, the driver, etc., to the base of the switch. If the waveform appears on the driver base but not on the collector, and there are no pulses on the switch base, the SCR has probably fired or shorted. The gate pulse comes through a Zener diode from the switch emitter; check this too. Normal emitter voltage for the switch transistor is 1.1 (read this to the isolated ground). If this voltage is OK but the SCR still fires, check the SCR. The normal anode voltage on the SCR when it is not firing is +24. When it *is* firing, this voltage should read almost zero.

These DC power supplies are vulnerable to high-transient voltages from a lightning hit on the AC power line. One came in recently with three transistors, two diodes and some other parts blown on the JA panel. After these components were replaced, the set would not work normally—the high voltage was low, etc. The waveform on the shaper collector was badly off. This transistor was quite leaky; replacing it restored normal operation.

After repairs were "completed," a very odd symptom showed up when this set was tested. The picture was good, but it had an intermittent loss of both syncs. The vertical lines in the picture showed five or six large bends or waves in each line that constantly moved. If this kind of symptom turns up, check the tuning of the free-wheeling blocking oscillator on the JA panel. The cause is that this oscil-

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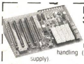

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lator is actually hunting and won't lock into the horizontal sync as it should. The factory service data lists this adjustment as "the regulator sync-level adjust"; it's a large coil (shown as T2 on the schematic) opposite the output-voltage control pot on the panel. If you must adjust this small pot, which is factory-sealed and preset, don't break the seal; if you do you also break the control! Just remove the original control, put in a new one, and then adjust it for the proper DC voltage levels. Then seal it using the cement that comes with it.

The JA panel is a replaceable module. However, you can troubleshoot it on your bench, and save a good deal of time and money. If you use the proper methods and test equipment, this troubleshooting doesn't take very long. Although the circuitry looks quite complex, it is actually quite simple, and the necessary waveforms and voltages can be traced and checked without much trouble. Good luck. **R-E**

service questions

EVERYTHING WEAK

Here's one for the books. This Zenith *model 19DC11* had low vertical sweep, low boost voltage, poor color, poor video, etc., etc., and it took far too long to come on. The B+ voltage was OK. Of course, all this was intermittent.

Guess what? The filament transformer winding on T204 had a very bad *ground* connection! The heaters read only 4 volts.

Thanks to Tom Niderost, Tom's Audio Service, Ukiah, CA, for this one.

DEAD TUBES

I've got a problem! The tubes won't light up in this GE table model (model M151SBK). The B+-voltage is OK, and the whole heater string checks out all-right from the on-off switch. I'm lost.—S. W., Dallas, TX.

First, because the tubes don't light, and second, the tube heaters check out OK, we know there's an open circuit *somewhere.*

In this chassis, your problem could be in the INSTANT-ON switch, which is between the on-off switch and the interlock. Check this with an ohmmeter, or just turn the set on and see if you don't read the full AC line voltage across the closed switch terminals. I suspect that you will.

TRANSISTOR SUB NEEDED

I've got a GE QA chassis with a bad red driver transistor in the video. I haven't been able to locate a substitute or a factory part number for it. Can you help?—F. W., Bronx, NY.

The GE part number for this transistor

continued on page 102


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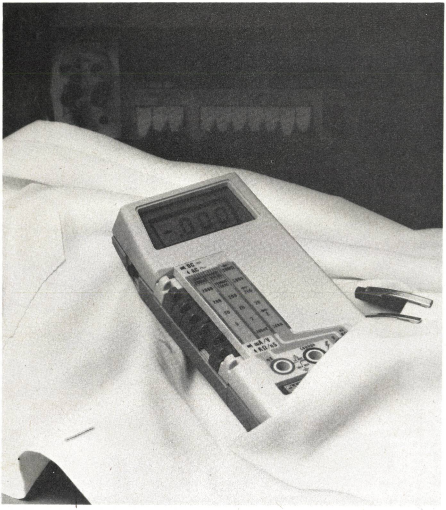

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SERVICE QUESTIONS

continued from page 100

and the other video drivers is EP15X18. You can replace it with an RCA SK-3044, a Sylvania ECG-154 and others. Oddly enough, the GE *Transistor Guide* does not show a replacement for this part number!

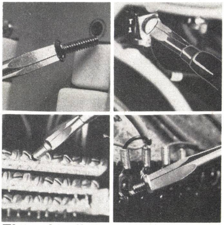
DISAPPEARING RASTER

There's an odd problem in this Quasar model TS-915F. The raster is present but it's out of focus. When I adjust the focus control, the raster disappears. I can't find any change in any DC voltage except for the picture tube cathodes, which change from +150 volts to +240 volts.—R. F., Hialeah, FL.

The *model TS-915F* chassis has a focus-dropping resistor network. From the low end of this, they go through a focus control. That seems to adjust the picture tube *screen* voltages. The focus voltage is taken off at a fixed tap on the focus-dropping network. Your trouble is probably in the focus voltage. Check if the screen voltage drops very low on the picture tube. If so, this causes the tube to be cut off, the beam current drops to zero and the cathode voltage rises with no load. Make sure to check the focus voltage. If you lose it, the raster cuts off, even though the high voltage is still up.

continued on page 106

Use Quick Wedge to repair a control panel, hook up a power monitor, connect a power supply, install a motor starter



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new lit

More information on new lit is available from the manufacturers of items identified by a Free Information number. Use the Free Information Card inside the back cover of this issue.

REPLACEMENT COMPONENTS, *Catalog 10,* contains 6 pages crammed with over 400 original Japanese IC's, transistors, tape heads, ceramic filters, special devices and repair kits for servicing all electronic equipment and TV sets. Each part is illustrated and described together with prices. An ideal source book for many hard-to-find components.—**Ora Electronics,** 7235 Canby Ave., Reseda, CA 91335.

CIRCLE 29 ON FREE INFORMATION CARD

POWER TOOL CATALOG is a handy 20-page guide for hobbyists, experimenters and lab technicians, describing a wide variety of *Moto-Tool* kits, accessories and attachments that can be used in many hobby, woodcarving, lapidary, leatherwork and do-it-yourself projects. Featured are a complete multipurpose tool workshop, a heavy-duty tool kit with accessories, a tool holder, a drill press, plus patterns and how-to books. Price: $1.—**Dremel Manufacturing,** 4915 21st St., Racine, WI 53406.

NEW CB RULES, *Plain English Rules—Citizens Band Radio Service,* approved in August, 1970, by the FCC, written in question & answer format in plain language. Rules are listed numerically and include such topics as: how to apply for a license, what kinds of operations does a license cover, use of power amplifiers, how to use a CB in emergency situations, etc. Price: $1.25 (make check/money order out to Superintendent of Documents).—**CB Handbook,** Consumer Information Center, Dept. 109 F, Pueblo, CO 81009.

HEATHKIT CATALOG, *No. 841,* has 96 pages describing hundreds of electronic kits and other products designed for home improvement and entertainment. Included among the kits are personal computers, hardware/software, and floppy-disc systems; oscilloscopes and frequency counters; weather instruments; a greenhouse, etc. New items featured are: a 3-way linear-phase hi-fi speaker system; a logic probe for checking TTL/CMOS digital circuits; an FM intercom; a hand-held aircraft navigation computer; and two mobile FM amplifiers.—**Heath Co.,** Benton Harbor, MI 49022.

CIRCLE 50 ON FREE INFORMATION CARD

WORKSHOP/HOME TOOL CATALOG, 56 illustrated pages showing hundreds of tools and products for workshop, craft and hobby, home improvement, automotive, kitchen and outdoor applications. Among some of the items described are chisels, drill bits, pliers, glass cutters, screen repair kits, soldering aids, a drill press, center punch, planes, sanders and many more. A handy order form is enclosed.—**Consumers Bargain Corp.,** 109 Wheeler Ave., Pleasantville, NY 10570.

R-E

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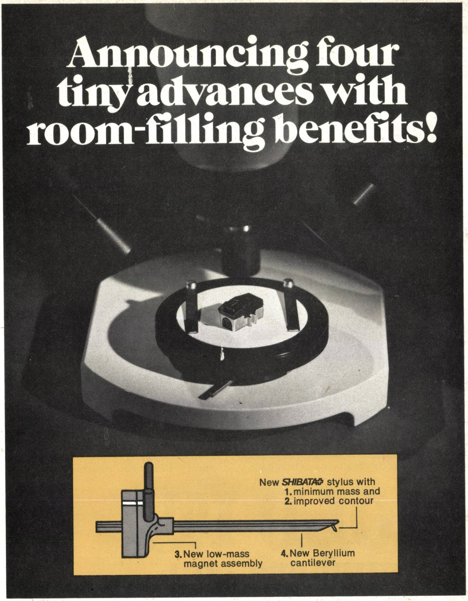

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STRING SYNTHESIZER
continued from page 75

There are three points where each tone block differs from the others. These points are the coded markings for the connections to coded points on the keyboard. There are thirty-seven terminals marked 1 to 37 which connect to correspondingly marked (K1 to K37) on the tone blocks. Terminal pads K1, K13 and K25 are on the C tone block as you can see in Figs. 2 and 12. Terminal pad markings for the twelve keys are, reading left to right from the component side of the boards:

Tone Block	Pad Markings
C	K1, K13, K25
B	K12, K24, K36
A#	K11, K23, K35
A	K10, K22, K34
G#	K9, K21, K33
G	K8, K20, K32
F#	K7, K19, K31
F	K6, K18, K30
E	K5, K17, K29
D#	K4, K16, K28
D	K3, K15, K27
C#	K2, K14, K26

Figures 14 and 15 are foil pattern and parts layout for the 1550C board. Figure 16 is the foil pattern for the 1550LED board that is mounted on the shaft of R58, the MODULATION RATE control. Figure 17 shows the component location. The board is mounted with the foil side facing the body of R58 and away from the rear surface of the control panel. The three LED's are mounted from the component side of the LED board. The resistors and all other connections are tack-soldered to the foil on the etched side of the board. Note that the flat side of the LED casing identifies the *cathode* lead which corresponds to the *negative* markings on the placement diagram.

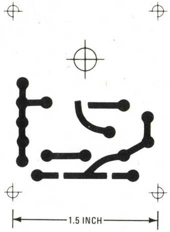

FIG. 16—FOIL PATTERN for the LED board that mounts on the shaft of potentiometer R58.

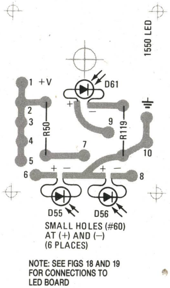

FIG. 17—PARTS PLACEMENT on the LED board. Note the LED's are on the component side; the resistors are tacked to foil side of board.

Figure 18 shows the positioning of the controls on the panel along with interconnections between the various components. The connections shown should be made before adding the connections from the control panel to the PC boards as shown in Fig. 19. Note that the first on-board connections have been deleted for clarity. The coding at the end of each lead indicates the point of origin of that lead. The letters in parenthesis denote the board from which the wire originates. Be sure to use shielded cable or small-diameter coax where indicated in Fig. 19.

continued on page 108

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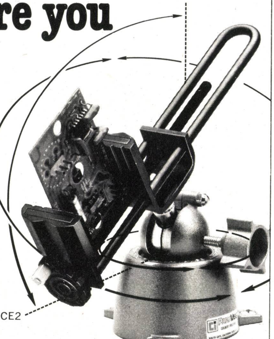

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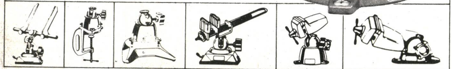

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books

THE COMPLETE HANDBOOK OF VIDEOCASSETTE RECORDERS, by Harry Kybett. TAB Books, Blue Ridge Summit, PA 17214. 280 pp. 5¼ × 8½ in. Hardcover $9.95.

Written in easy nontechnical language, this book tells students, educators and industrial users of videocassette and closed-circuit TV systems how to operate and maintain these systems. The book is divided into two sections: the first deals with operation and practical examples of copying, editing and close-to-broadcast situations; the second section concerns itself with the simple care and maintenance required by a modern TV system using cassettes.

USING DIGITAL AND ANALOG INTEGRATED CIRCUITS, by L. W. Shacklette and H. A. Ashworth. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 305 pp. 6 × 9 in. Softcover $10.95.

This book, which is geared to scientists and technicians, is an illustrated guide to digital and analog IC's, with the emphasis on practical application. The text contains many "do-it-yourself" lab exercises and projects. TTL and COS/MOS circuits are covered in the section on digital IC's; only inexpensive series 300 and series 700 op amps and series 7400 TTL and series 4000 COS/MOS circuits are used. Appendixes include a section on equipment and supplies, data sheets, references, a logic probe, regulated IC power supplies and a glossary.

DBUG: An 8080 Interpretive Debugger, by Christopher A. Titus and Jonathan A. Titus. E&L Instruments, Inc., 61 First St., Derby, CT 06418. 100 pp. 9 × 6 in. Softcover, $5.00.

This first of the Bugbook series on microcomputer assembly language programming can be used to enter and single-step a program instruction-by-instruction. Data and program steps stored in RAM can be entered and changed using the breakpoint feature to observe the effect of an instruction on the microprocessor's internal registers. One complete instruction is stepped-through regardless of the number of cycles.

The I/O routines were written for reading and punching paper tape with a teletypewriter, but can be easily adapted for use with magnetic tape cassettes or CRT terminals. Two complete DBUG listings are contained in the appendixes—one in octal code, the other in hexadecimal format.

8080A/8085 ASSEMBLY LANGUAGE PROGRAMMING, by Lance A. Leventhal. Osborne & Associates, Inc., P.O. Box 2036, Berkeley, CA 94710. 439 pp. 5¼ × 8 in. Softcover, $7.50.

Although there are many textbooks that deal with the principles and uses of BASIC program language, assembly language programming has had no such accompanying text—this book fills that gap. It is a primer that is geared to those with a computer background but with little or no knowledge of assembly language programming. However, it can also be used as reference material by those who are already familiar with this type of programming. Chapter 1, which is a general introduction, discusses program instructions. Chapter 3 deals with the 8080A and 8085 instruction sets; and other chapters examine simple programs, loops, character-coded data and data conversion, subroutines and interrupts, and debugging. Chapter 16 outlines two sample projects.

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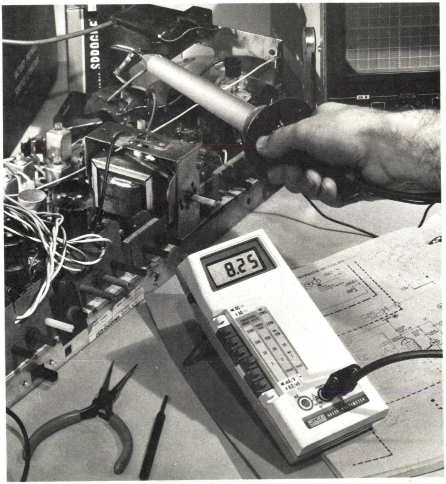

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ADVANCE ELECTRONICS

continued from page 102

FOCUS PROBLEM

Too much focus voltage is the problem in this Zenith 19EC45; 7500 to 8500 volts. The picture tube is OK, and I've checked and subbed everything I can think of in the high-voltage circuit, except the high-voltage tripler. Do you think this is the cause?—C. H., Ocie, MO.

"Yes!"

SHORT-LIFE TUBES

This Sears model 9180 has frequent failures of the 6AW8 video-amplifier tube. The first time this happened, the video was weak; so I changed the 6AW8 tube and it worked. Three weeks later the 6AW8 tube was bad again. I was out of 6AW8's, so I tried a 6LF8. The set worked for three months, then it came back again with a bad 6JE6. The video was still OK. The 6LF8 tube isn't listed as a substitute for the 6AW8 in the substitution manual. So I put the 6AW8 tube back in the set. Three weeks later, the same problem occurred! This time I put a 6LF8 tube in it and it's still working. Incidentally, all DC voltages around this stage are very close to specifications. What do you think is wrong?—W. S., Hillsboro, MO.

I wish you hadn't asked! The only half-way logical explanation I can see is a bad run of 6AW8 tubes. I recall that some time ago we ran into similar problems with 6AW8's. They finally cleared up. I do not understand why the 6LF8 tube isn't listed as a substitute; it's about as close to a 6AW8 tube as possible.

GUNS MOUNTED VERTICALLY

A man who rebuilds picture tubes tried to sell me a rebuilt in-line, GE Portacolor tube. I noticed the three guns were mounted vertically! So, I wouldn't buy it. He said the vertical mounting would make no difference. Was I correct?—E.M.I., Mexico City.

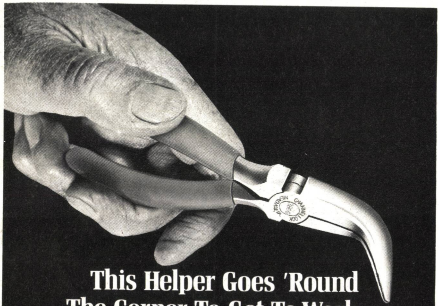
Yes, indeed!

BLANKING PROBLEM

The raster in this GE model 19JA chassis is very odd-shaped! The upper third is blanked out—on a line from the top right-hand corner to the middle of the left-hand side! You suggested checking the blanking circuits. I found that if I disconnected R190 (which feeds collector of blanker transistor Q112) the raster filled out and the picture was fine. I found later that I could disconnect C164, 1.0 μF (this feeds the blanking into the base of the video output) with the same result. Now, I don't know where I am.—R. R., Waring, TX.

Both of these parts will disable blanker transistor Q112. Therefore, your problem *is* in the blanking. Since these parts are good, the most likely cause of your trouble is a leaky blanker transistor (Q112).

continued on page 134



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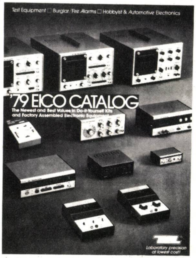

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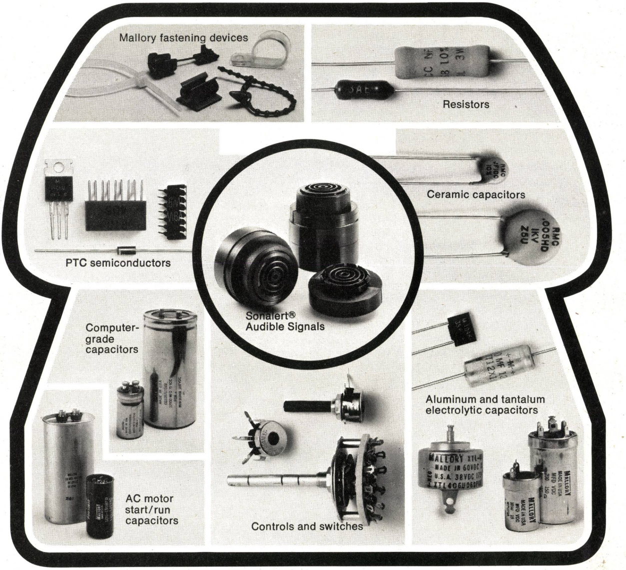

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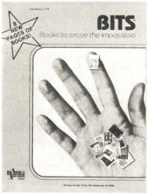

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STRING SYNTHESIZER

continued from page 104

Putting it all together

The assembly of the 12 chromatic tone generator blocks involves a lot of repetitive assembly work. Be forewarned that it's boring during this stage of assembly, and remember to get up and take a break when you feel yourself getting tired. Attention to detail will save a lot of troubleshooting in the final stages. Second, notice that there are a lot of CMOS IC's used in this instrument. Thus, remember to use handling precautions with the IC's. Store them in conductive foam or tinfoil; don't wear synthetic materials (nylon, rayon, etc); use a grounded or DC soldering iron if possible, or let your standard iron warm up before unplugging and then solder a few IC's while the iron is still warm. Alternatively, use sockets on the IC's to help eliminate much of the handling. Observe orientation markings on all IC's and the many diodes required for this circuit.

There are seven bare-wire jumpers in each tone block on the 1550A and 1550B circuit boards, and fourteen jumpers on the 1550C board. In each tone block, the input signal comes from the appropriate tone output of the top octave generator IC7 on the 1550A board. These connections should be made with insulated wire. Note that the A and B boards are designed to be "stacked" over each other. The B board is mounted above the A board using No. 4 × 1-inch or 1½-inch machine screws and ¾-inch spacers. Once these boards are sandwiched, the connections from the inputs of the 6 tone blocks on the B board can be connected to the appropriate tone outputs of IC7. Also, there are 10 buses that run the length of each board. Short insulated jumpers are used to tie the B-board buses to similar points on the A board. The duplicate holes on the A board are then used to make the connections to various points on the front panel and C board. The four audio signal buses should have their connections made with shielded wire to avoid noise pickup (MVH, MVL, MCH, MCL).

On the 1550C board the CMOS and semiconductor soldering precautions still apply. The two voltage regulators mounted on this board have small clip-on heat sinks (Thermalloy 6043 or similar) to aid in heat dissipation.

In addition to five jacks, eight controls, and two switches, the front panel should serve as mounting for R101, R119, R50, R129, R51, R53, and R57. The small 1550LED board will hold R119 and R50 in addition to the three LED's. This board is mounted on the shaft of R58 and positioned to allow the LED's to protrude through front panel holes. See Figs. 17, 18 and 19.

In preparing the organ keyboard, note that two switch buses are required. In each case there should be a common bus running the length of the keyboard. One set of switches on each note provides for 37 independent terminals to contact a main bus rod. The other set of switches are all common, such that **ANY** key being pressed will cause a switch closure between the second "trigger" bus and a 38th terminal. The trigger bus is used to enable the output noise gate and gate trigger, and connects to board C at points G and H. The individual key outputs are connected to the proper tone blocks of the A and B boards. The bus associated with these key outputs is connected to +V.

PARTS LIST FOR MAIN AND HIGHEST C TONE GENERATORS

Resistors, ¼ watt, 10% or better
R37—1000 ohms
R38, R39, R42, R44, R47—10,000 ohms
R40, R57—100,000 ohms
R41, R50—2200 ohms
R45, R46—220,000 ohms
R48—1800 ohms
R49, R52, R54-R56—5000 ohms pot
R51-R53—4700 ohms
C10, C11—10 μF, 10 volts electrolytic
C12—33 μF, 10 volts electrolytic
C13—47 pF disc
C14—.01 μF disc
C15—.05 μF disc
D44-D54—1N914 or 1N4148 diode
D55, D56, D61—TIL209B LED
IC5—4013 dual flip-flop
IC6—4011 quad NAND gate
IC7—MK50240 top-octave generator
S2—SPDT switch
J1, J2—closed-circuit jack

Testing and calibration

After completing assembly, double check for cold solder joints, loose wire clippings and so on. Apply power and look for a pulsing rate LED and one of the split select LED's as a power indicator. Check the voltages on the C board at points "+V" and "−V." These should be about ±10 or 11 volts. The actual voltage is not as important here as the fact that it is regulated. Resistors R131 and R134 should give a voltage variation of about 1 or 2 volts. Set these trimmers to midpoint and proceed.

Connect the MIX output to a standard guitar or hi-fi amplifier. Set all controls to midrange except PIANO, which should be at minimum. Playing a few notes on the keyboard should now yield a reedy organ-type tone. Adjust BIAS trimmer R66 on the C board. At one point during the rotation, you should notice a considerably fuller sound as the chorusing circuits come into bias and add another two voices to the overall sound. Set R66 for the center of the "fullness" area and proceed.

The four trimmers near IC8 and IC9 on the C board are primarily for the perfectionists among us. If you do not have access to a scope, set R68, R73, R78

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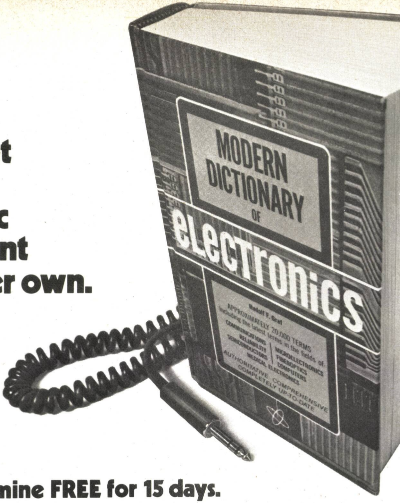

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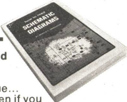

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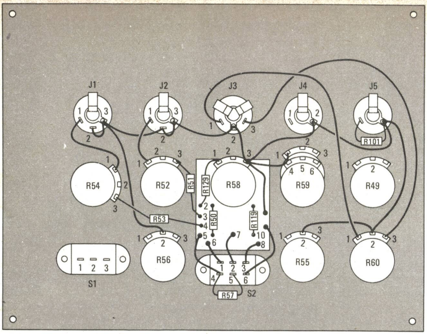
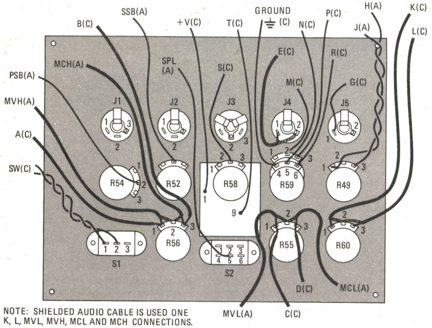


FIG. 18—COMPONENTS ON THE CONTROL PANEL—where they are mounted and how they are interconnected. Be sure LED board mounts with foil side to the rear.



NOTE: SHIELDED AUDIO CABLE IS USED ONE K, L, MVL, MVH, MCL AND MCH CONNECTIONS.
LETTERS IN PARENTHESIS DENOTE BOARD FROM WHICH WIRE ORIGINATES

FIG. 19—ON-BOARD CONNECTIONS eliminated so you can clearly see interconnections. Letters in parenthesis designate destination PC board.

PARTS LIST FOR MIXING AND CHORUSING CIRCUIT

Resistors ¼ watt, 10% or better
R61—R65, R70, R76, R78, R80, R88, R91, R94, R100, R104, R107, R110, R113, R122, R127—10,000 ohms
R66—50,000 ohms trimmer pot
R67, R72, R77, R82, R103—10 ohms
R69, R74, R79, R84—2700 ohms
R71, R81, R86—22,000 ohms
R87, R88, R97, R99, R105, R108, R111, R114, R120, R123, R128—100,000 ohms
R89, R90, R92, R93, R96, R106, R109, R112, R115—1000 ohms
R95—270,000 ohms
R102—100 ohms
R117, R118, R124, R125—4700 ohms
R121—15,000 ohms
R126—8200 ohms
R130, R132, R133, R135—470 ohms
R68, R73, R78, R83, R116—1000 ohms trimmer pot
R131, R134—1000 ohms trimmer pot

Capacitors, electrolytic, 10 volts or greater unless otherwise noted
C16–C19, C24, C29, C32, C36, C37, C38, C40—1 μF
C46, C49, C50, C55—10 μF
C51, C52, C56, C57—5 μF

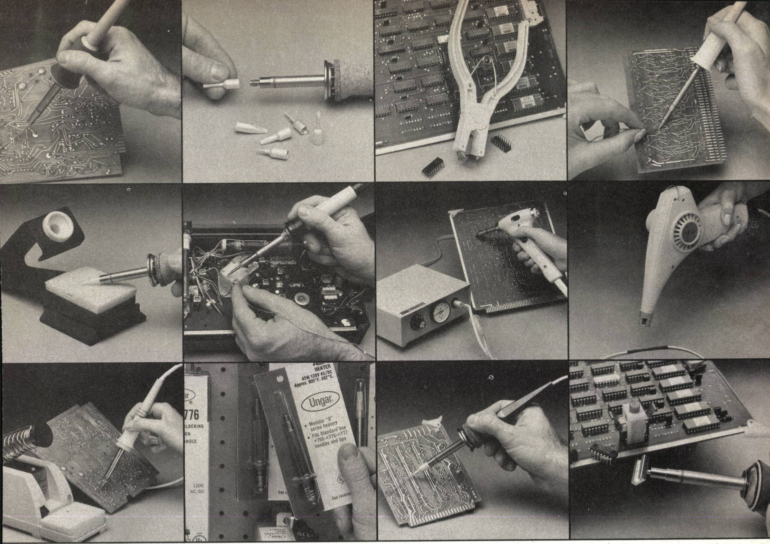
Capacitors, disc ceramic unless otherwise noted
C20—500 μF
C21, C41—0.1 μF
C22, C26, C30, C34, C42, C43—.05 μF
C23, C25, C27, C31, C33, C35, C45, C48, C54, C59—.001 μF
C39—0.1 μF Mylar
C44, C47—100 pF

Semiconductors
Q1–Q3, Q5—2N5139
Q4—2N5129
IC8, IC9—SAD-1024 delay line
IC10—4136 quad op-amp
IC11—CD3080 transconductance amplifier
IC12—4013 dual flip-flop
IC13–IC16—NE566 VCO

and R83 to mid-rotation and proceed. These trimmers are used to balance the outputs of the delay lines, a process which minimizes distortion and clock feed-through. To set these trimmers, view the signal at the wiper of the trimmer. At either end of the trimmer's rotation, you will see two representations of the audio signal, each riding at a different DC level. Near the middle of the trimmer's rotation, the two signals will converge and appear as one. This is the correct setting. Repeat the procedure for the remaining three trimmers.

The final trimmer on the C board is the RATIO trimmer, R116. This adjustment is interactive, and best made over a period of time to allow optimum adjustment for all applications and environments. In order to actually hear the effect of this control, a small clip lead should be used to jumper point G to +V. This will turn on the output noise gate without having any keyboard signal present. You will hear two noises. One is a hissing due to the clocking and switching occurring in the delay lines. This is normal and easily masked when keyboard tones are present. The second noise will be a periodic popping or ticking. This is actually an audio beat frequency which is caused by the two high-frequency clocking oscillators that are being independently modulated for the chorusing effect. If the ratio between these two oscillators is just right, the beat frequencies dip into the audio passband. Slight adjustment of R116 will shift the frequencies of the VCO's in an inverse proportion. Listen for the quietest point and leave the trimmer. Note that this adjustment may need to be altered after about 20 hours of operation. This is due to the aging of components which may cause slight changes in values and slight changes of frequencies, etc. The power supply trimmers, R134 and R131, are interactive with the RATIO trimmer. If you have trouble finding a quiet spot along the rotation of R116, the power supply voltages can be shifted very slightly to throw the RATIO trimmer into a whole new range. However, in most cases, the voltage trimmers may be left at mid-point.

At this point you are ready to experiment with the front panel controls, and begin experiencing the versatility they offer. **R-E**



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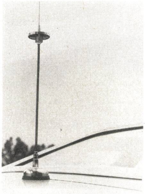

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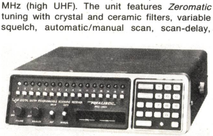
Also available are the *models 521SS, 522SS, 523SS* and *524SS,* all featuring the *Enterprise* antenna with various mounts. The *model 521SS* includes antenna, the *model 101* mirror mount, cable and connector. The *model 522SS* is a double kit with two antennas, mirror mounts, co-phase harness and connector. The *model 523SS* contains antenna, the *model 114* trunk mount, hardware, miniconnector, cable and connector. The *model 524SS* kit includes antenna, the *model 301* magnet mount, cable and connector. Retail prices: *model 521SS,* $26; *model 522SS,* $50; *model 523SS,* $27; *model 524SS,* $30.—**Valor Enterprises, Inc.,** 185 W. Hamilton St., West Milton, OH 45383.

SCANNING MONITOR RECEIVER, *model PRO-2001,* uses microprocessor technology to scan 16 programmed channels; digital keyboard enters up to 16,560 frequencies. Six-band capability ranges from 30–50 MHz (low VHF) and 470–512 MHz (high UHF). The unit features *Zeromatic* tuning with crystal and ceramic filters, variable squelch, automatic/manual scan, scan-delay,



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channel lockout, high-speed skipper circuit, speaker and input jacks. Power requirements are 120 VAC or 12 VDC, and cables and mobile mounting bracket are included. The *model PRO-2001* measures $3\frac{3}{8} \times 10\frac{9}{16} \times 10\frac{7}{8}$ inches and sells for $399.95.—**Radio Shack,** 1400 One Tandy Center, Fort Worth, TX 76102.

SIGNAL STRENGTH INDICATOR, *Signal Hunter Digital S-Meter,* is designed to operate with either a CB base station or mobile transceiver, and can be used in conjunction with or replace a standard S-meter.

A 3-digit LED readout provides highly visible displays to 1/10 of an S-unit, with signals greater than S9 displayed in dB. Controls include built-in on-off switch and calibration control. Power is supplied by 12 VDC; the unit measures 10.8 cm W

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× 3.8 cm D × 4.6 cm H, and comes with a magnetic mount. Price: $49.95 plus $2 postage.—**Digi-Comm,** Suite 110, 720 Ste. Catherine St. West, Montreal, Canada H3B 1B9.

COMMUNICATIONS RECEIVER, *model FRG-7000,* has a frequency range from .25 kHz to 29.9 MHz on SSB, AM and CW (code) modes. Specifications include: Sensitivity—SSB/CW, better than 0.7 μV for 10-dB S/N ratio, and for AM, better than 2 μV for 10-dB S/N; drift is less than ±500 Hz; audio output is 2 watts. Operates at

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100–234 VAC 50–60 Hz. The unit measures 360 cm × 125 cm × 295 cm and weighs 7 kg. Amateur net price: $629.—**Yaesu Electronics Corp.,** Box 498, 15954 Downey Ave., Paramount, CA 90723. An ideal receiver for hams, SWL's and mariners. **R-E**

MORSE CODE TRANSCEIVER, *model MRS-100,* comes as a partial kit, full kit or assembled and is designed around a microprocessor to generate signals using ASCII or Baudot terminals.

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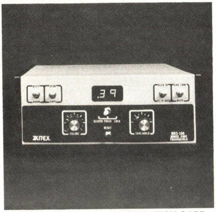

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provides automatic sync from 1 to 150 words-per-minute while the machine is continuously computing and displaying the corresponding WPM value. Send mode controls output from 1 to 150 words-per-minute.

Also included is a special RTTY Emulate mode to transmit 60-character ASCII subset using standard Morse code plus "new" codes defined by special symbols and control characters (line feed, space, etc.) Applications include military, amateur and some commercial communications systems. Suggested retail prices: for the partial kit, $95; full kit, $225; factory assembled, $295.—**Xitex Corp.,** 13628 Neutron, Dallas, TX 75240.

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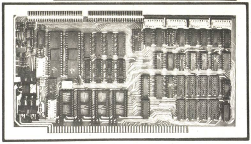

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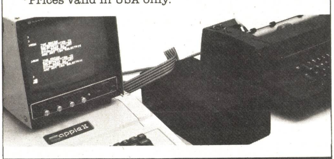

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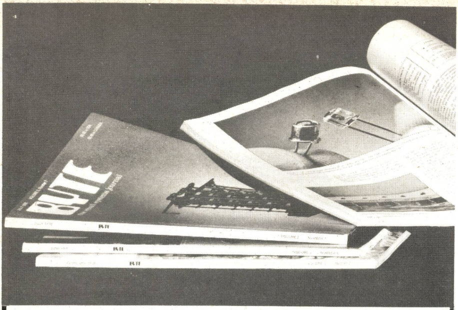

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METAL TAPE PLAYER
continued from page 86

then be played back on existing Dolby cassette decks.

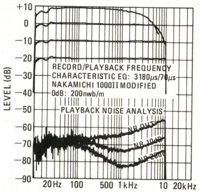

FIG. 9—RECORD/PLAYBACK RESPONSE of Nakamichi's prototype *model 1000 II ZX* cassette deck using type ZX metal-particle tape.

Nakamichi prepared a diagram (see Fig. 8) that compares the advantages of an additional 10-dB of noise reduction. Figure 8 shows that a 400-Hz signal recorded at −30 dB (0-dB reference = 200 nanoWebers-per-meter) without benefit of any noise reduction is virtually buried in modulated noise. With 10-dB of noise reduction, the identical signal is considerably improved, while with a full 20-dB of noise reduction, the signal

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almost resembles the original source signal waveform shown in the top portion of Fig. 8.

Table 1 is a reproduction of Nakamichi's compilation of dynamic range comparisons. The left-hand column shows the dynamic range that can be achieved at various frequencies using Nakamichi's highest-quality deck, using the Dolby-B system and the company's SX tape (similar to TDK Type SA and Maxell type UD-XL-II). The column labeled "ZX/Telefunken" shows the dynamic range achievable at the same frequencies using a metal-alloy tape plus the proposed Telefunken 20-dB noise-reduction system. The right-hand column shows a net improvement in dynamic range at each listed frequency. The vast improvement indicated suggests that perhaps we should take a second look at whether or not there is a real need for home digital tape recording at the present time.

Figure 9 represents the record-playback response and noise characteristics of the Nakamichi *1000 II ZX* prototype machine using ZX formulation metal-particle tape and the built-in Telefunken noise-reduction system. Compare these results with what you can presently achieve on your own cassette deck (even a fairly expensive, high-quality model) and you will have to admit that the future looks bright for the recordist whose favorite medium is the cassette. **R-E**

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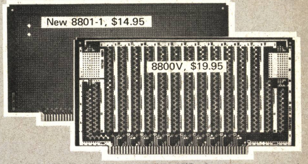

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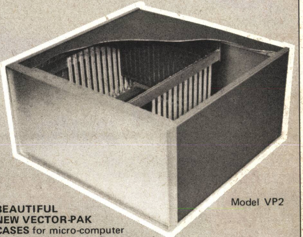

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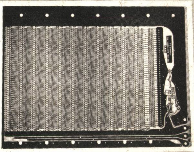

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AUDIO TEST STATION
continued from page 83

centerpoint. When this is accomplished, R4 (with S9 in the manual mode) will produce the same sweep as the triangle timebase did with switch S9 in the sweep mode.

Set S9 to MANUAL.

Sweep the horizontal amplifier of the scope by running R4 thru its full travel. Be sure that when R4 is at its end-points, the beam rests on an end vertical line on the CRT graticule.

Switch S12 to LINEAR.

Set R4 to zero.

Adjust R11 for the desired center frequency.

Move R4 to its lowest position.

Set R10 for the desired low-frequency limit.

Move R4 to its upper position. Check for desired high-frequency limits. Several adjustments of R10 and R11 may be necessary.

Adjust R9 to its low frequency and then back off three turns.

Run R4 thru its full travel. Watch the beam as it moves horizontally across the scope and stop at each centimeter mark. Observe the frequency of each mark. A perfect log sweep would have the frequencies shown in Table 1.

Adjust R401 and R403 for best fit with those frequencies listed. It is valuable to be able to occasionally look at the waveform at the output of IC501 as was done when the first approximate adjustments of R401 and R403 were made. This is because it is easy to grossly misadjust R401 or R403. Looking at the output waveform out of IC501 provides a close approximation from which to perform final adjustments.

With S9 on SWEEP, run R4 on its lowest position. Set the desired low-frequency end-point by using R9.

Move R4 to its upper position and set

TABLE 1

cm	Hz
0	20
1	40
2	80
3	160
4	320
5	640
6	1280
7	2560
8	5120
9	10,240
10	20,480

the upper frequency end-point using R8.

Recheck the lower end-point.

This wraps it up for this month. We still have to cover the voltmeter and frequency counter sections and will then conclude with additional calibration data and application details. **R-E**

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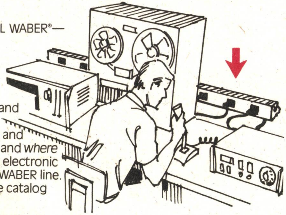

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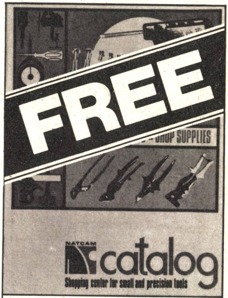

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SERVICE MANAGEMENT REFERENCE INDEX, compiled by the Education Committee, National Association of Service Managers, 6650 Northwest Highway, Chicago, IL 60631. 67 pp. NASM members price, $3; nonmembers, $4.50.

This comprehensive checklist is in looseleaf form, which makes it convenient for use not only as a reference book, but for later insertion of new reference material. The series of alphabetically arranged checklists covers 26 service management topics, including Budgeting, Installation, Customer Relations, Labor Relations, Personnel, Technical Assistance, Warranty, etc. A separate three-ring looseleaf binder is also available for $10, plus shipping charges.

MICROPROCESSOR PROGRAMMING FOR COMPUTER HOBBYISTS, by Neill Graham. TAB Books, Blue Ridge Summit, PA 17214. 378 pp. 5 × 8¼ in. Softcover, $8.95; hardcover, $12.95.

This book contains much detailed, while simply written, information on intermediate and advanced programming and data-structure techniques. It is divided into six sections, proceeding from basic number systems to internal and external sorting methods. Topics covered are data structures, from simple arrays to complex multiple-linked chains for "string variables"; searching, indexing and storing techniques; how to retrieve information; an arithmetic-based "linear congruential" random-number technique for computer game enthusiasts. Most important, it gives a simple direct method for writing programs; sample programs are included for each technique. While the language used is PL/M, there are instructions for conversion to assembly code for any variety of computer.

EXPERIMENTS WITH DIGITAL CIRCUITS, A LABORATORY MANUAL FOR USE WITH THE DIGI-DESIGNER, Second Edition, by Dr. Jack Cazes, supplemented by Bill Grubbs and Gerald Pullen. E&L Instruments, Inc., 61 First St., Derby, CT 06418. 143 pp. 9 × 11 in. Softcover, $9.

This revised volume (in punched-paper format for three-ring binder insertion) was specifically designed for use with the *model DD-1 Digi-Designer.* It combines a series of 26 experiments together with background data and exercises for a complete introductory course in digital electronics. Thirteen of the experiments concern combination logic, from simple gates to a 32-function ALU (*A*rithmetic *L*ogic *U*nit). The next 13 experiments in sequential logic pass from flip-flops to counters, scalers, shift registers and decoders. The text contains complete diagrams on how to set up the experiments on the *Digi-Designer;* truth tables; and supplementary exercises. These exercises accompanying each of the twenty-six experiments provide additional questions and require the student to analyze and make deductions from the experiment he has just performed. In addition, the student is encouraged to study closely related topics in references and to analyze variations in the basic experiment. The appendix provides discussions of Boolean algebra, binary and BCD notation, binary/decimal conversion and binary arithmetic.

THE ABC BOOK OF HI-FI/AUDIO PROJECTS, by George Delucenay Leon. TAB Books, Blue Ridge Summit, PA 17214. 182 pp. 5 × 8¼ in. Softcover, $4.95; hardcover, $7.95.

This "roll-your-own" guide to building more than 100 projects is designed for the hi-fi buff, beginner or advanced. Each project comes with a complete schematic wiring diagram and parts list; some projects even have PC board layouts. You learn how to design circuits, create new audio power supplies, build amplifiers, use timer circuits, plus many more projects. Not only utility circuits are covered, but also those designed for entertainment: a party lie detector, toy organ, metronome, white-noise generators, etc. The appendix explains resistors and capacitors, shows IC pin connections and lists components supply sources.

THE DESIGN OF OPERATIONAL AMPLIFIER CIRCUITS, WITH EXPERIMENTS, by Howard M. Berlin. E&L Instruments, Inc., 61 First St., Derby CT 06418. 55 pp. Softcover, $8.50.

This latest in the *Bugbook* series deals with the design and operation of operational amplifiers, an essential electronic system building block. While mainly directed at the beginning experimenter or hobbyist, the book can also be used to supplement college lab courses. Among the topics covered are op-amp fundamentals; linear amplifiers; differentiators and integrators; voltage and current converters; comparators; rectifiers; oscillators; active filters; and power supplies. A series of 35 experiments is given that can be performed using inexpensive, easily obtained components and breadboarding aids. The mathematical derivations of op-amp closed-loop responses are included in the text. **R-E**

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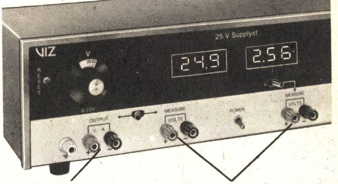

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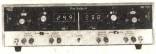

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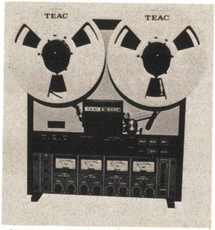

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Also available are the *model A-2300SR* 7-inch-reel tape deck and the *model A-3300SR* tape deck. Both are reversing units and feature three-motor transport tape, manual cueing, pushbutton controls, mike/line mixing, bias and equalization switches, and VU meters. The *model A-6100 MK II* is a ½-track 2-channel stereo tape deck that includes a servo tension motor, timer, equalization switch, 20-dB mike attenuator and remote control switch. Suggested retail prices: the *model A-3440,* $1500; the *model A-2300SR,* $800; the *model A-3300SR,* $1050; the *model A-6100 MK II,* $1350.—**TEAC Corp. of America,** 7733 Telegraph Rd., Montebello, CA 90640.

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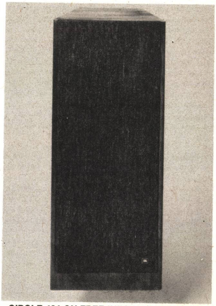

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compliance and large cone provide low-distortion response at high-volume levels. The 5-inch mid-range driver is housed separately, mounted on a sub-baffle and coupled to a refracting waveguide. The ring radiator has a constant-area phasing plug and exponential horn. The loudspeaker enclosure is a black walnut veneer, and has a charcoal brown grille. Suggested retail price: $875.—**James B. Lansing Sound, Inc.,** 8500 Balboa Blvd., Northridge, CA 91329. **R-E**

next month

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new products

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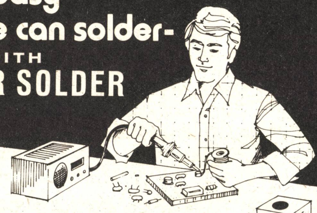

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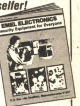

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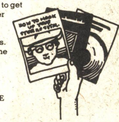

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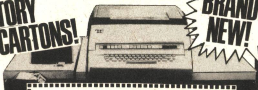

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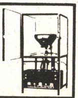

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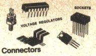

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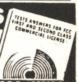

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2SA 234	.45	.53	.59
2SA 473	.45	.53	.59
2SA 484	1.50	1.75	1.95
2SA 495	.30	.35	.40
2SA 497	1.00	1.20	1.30
2SA 509	.30	.35	.40
2SA 561	.30	.35	.40
2SA 562	.30	.35	.40
2SA 564A	.20	.27	.30
2SA 634	.40	.45	.50
2SA 643	.30	.40	.45
2SA 673	.35	.40	.45
2SA 678	.35	.40	.45
2SA 682	.80	.90	1.00
2SA 683	.30	.35	.40
2SA 684	.35	.40	.45
2SA 695	.40	.53	.59
2SA 699A	.50	.64	.70
2SA 706	.85	1.00	1.10
2SA 719	.30	.35	.40
2SA 720	.30	.35	.40
2SA 733	.20	.27	.30
2SA 747	4.20	4.40	4.90
2SA 818	.70	.80	.90
2SA 841	.20	.27	.30

2SB

TYPE	25-UP	10-24	1-9
2SB 22	.30	.35	.40
2SB 54	.20	.27	.30
2SB 75	.35	.40	.45
2SB 175	.20	.27	.30
2SB 186	.20	.27	.30
2SB 324	.30	.35	.40
2SB 337	.70	.80	.90
2SB 405	.30	.35	.40
2SB 407	.80	.90	1.00
2SB 434	.80	.90	1.00
2SB 435	.90	1.10	1.20
2SB 463	.90	1.10	1.20
2SB 473	.80	.90	1.00
2SB 474	.70	.80	.90
2SB 492	.60	.70	.80
2SB 507	.80	.90	1.00
2SB 528D	.70	.80	.90
2SB 595	1.10	1.40	1.50
2SB 596	1.10	1.40	1.50

2SC

TYPE	25-UP	10-24	1-9
2SC 281	.30	.35	.40
2SC 372	.20	.27	.30
2SC 373	.20	.27	.30
2SC 380	.20	.27	.30
2SC 394	.20	.27	.30
2SC 458	.20	.27	.30
2SC 495	.45	.55	.60
2SC 509	.35	.40	.45
2SC 515A	.80	.90	1.00
2SC 517	2.50	2.70	3.00
2SC 535	.30	.35	.40
2SC 634A	.35	.40	.45
2SC 696	1.00	1.20	1.30
2SC 710	.20	.27	.30
2SC 711	.20	.27	.30
2SC 730	3.00	3.20	3.40
2SC 732	.20	.27	.30
2SC 735	.20	.27	.30
2SC 756	1.50	1.80	2.00
2SC 756A	1.50	1.80	2.00
2SC 781	1.90	2.10	2.40
2SC 784	.30	.35	.40
2SC 799	2.00	2.20	2.50
2SC 828	.20	.27	.30
2SC 839	.30	.35	.40
2SC 867	3.20	3.40	3.70
2SC 867A	3.20	3.40	3.70
2SC 897	2.00	2.20	2.50
2SC 930	.20	.27	.30
2SC 945	.20	.27	.30
2SC 983	.50	.64	.70
2SC 959	1.10	1.20	1.30
2SC 1000BL	.35	.40	.45
2SC 1014	.50	.64	.70
2SC 1018	.60	.70	.80
2SC 1030C	1.80	2.10	2.40
2SC 1061	.70	.80	.90
2SC 1079	3.40	3.55	3.90
2SC 1096	.45	.55	.60
2SC 1098	.50	.64	.70
2SC 1111	2.10	2.50	2.80
2SC 1124	.80	.90	1.00
2SC 1172B	3.20	3.60	3.95
2SC 1173	.50	.55	.60
2SC 1226	.50	.55	.60
2SC 1226A	.50	.55	.60
2SC 1239	2.20	2.70	2.90
2SC 1306	1.30	1.45	1.60
2SC 1307	1.90	2.10	2.40
2SC 1318	.35	.40	.45
2SC 1383	.30	.35	.40
2SC 1384	.35	.40	.45
2SC 1419	.60	.70	.80
2SC 1675	.20	.27	.30
2SC 1678	1.10	1.25	1.40
2SC 1728	.70	.80	.90
2SC 1730	.45	.53	.59
2SC 1760	.70	.80	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	.50	.64	.70
2SC 1908	.30	.35	.40
2SC 1909	1.80	2.00	2.25
2SC 1945	4.50	5.00	5.60
2SC 1957	.60	.70	.80
2SC 1970	2.10	2.50	2.80
2SC 1978	5.40	6.00	6.60
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2166	1.40	1.60	1.80

2SD

TYPE	25-UP	10-24	1-9
2SD 72	.50	.64	.70
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 261	.35	.40	.45
2SD 287	2.50	2.70	2.90
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80

FET

TYPE	25-UP	10-24	1-9
2SK 19BL	.45	.55	.60
2SK 23	.70	.80	.90
2SK 30	.40	.45	.50
2SK 33	.60	.70	.80
2SK 55	.60	.70	.80
3SK 22Y	1.40	1.60	1.80
3SK 39	.90	1.10	1.20
3SK 40	.90	1.10	1.20
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
3SK 48	3.40	3.55	3.90
3SK 49	1.30	1.45	1.60

IC

TYPE	25-UP	10-24	1-9
AN 214Q	1.30	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 313	3.00	3.20	3.40
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1322	2.50	2.70	3.00
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1366	2.50	2.70	2.90
HA 1366W	2.50	2.70	2.90
HA 1366WR	2.50	2.70	2.90
LA 4031P	1.80	2.00	2.25
LA 4032P	1.80	2.00	2.25
LA 4400	1.90	2.10	2.40
LA 4400Y	2.00	2.20	2.50
LA 4420	2.00	2.20	2.50
M51513L	2.00	2.20	2.50
STK 011	3.80	4.00	4.40
STK 013	7.60	8.00	8.80
STK 015	4.20	4.40	4.90
STK 435	4.50	5.00	5.60
TA 7045M	2.00	2.20	2.50
TA 7060P	.70	.80	.90
TA 7061P	.90	1.10	1.20
TA 7062P	1.10	1.25	1.40
TA 7089P	2.00	2.20	2.50
TA 7202P	2.50	2.70	2.90
TA 7203P	2.50	2.70	2.90
TA 7204P	2.00	2.20	2.50
TA 7205P	1.60	1.80	2.00
TA 7310P	1.30	1.45	1.60
TBA 810SH	1.90	2.10	2.40
TC 5080P	5.00	5.20	5.80
TC 5081P	3.00	3.20	3.40
TC 5082P	3.40	3.55	3.90
UHIC 002	4.20	4.40	4.90
UHIC 004	4.20	4.40	4.90
UHIC 005	4.20	4.40	4.90
UPC 20C	2.10	2.50	2.80
UPC 563	1.90	2.10	2.40
UPC 575C2	1.30	1.45	1.60
UPC 576	1.90	2.10	2.40
UPC 592HZ	.70	.80	.90
UPC 1001	1.90	2.10	2.40
UPC 1008C	4.20	4.40	4.90
UPC 1020H	1.90	2.10	2.40
UPC 1025H	1.90	2.10	2.40
UPC 1154	2.00	2.20	2.50
UPC 1155	2.00	2.20	2.50
UPC 1156	1.90	2.10	2.40
UPC 14305	3.00	3.20	3.40
UPD 861	8.00	8.40	9.50
UPD 857	8.00	8.40	9.50
UPD 858	6.00	6.30	7.00
PLL 01A	3.00	4.20	4.60
PLL 02A	5.00	5.30	5.90
PLL 03A	7.60	8.00	8.80

DIODES

TYPE	25-UP	10-24	1-9
1S 84	.45	.55	.60
1S 332	.35	.40	.45
1S 953	.16	.18	.20
1S 1007	.35	.40	.45
1S 1209	.35	.40	.45
1S 1211	.35	.40	.45
1S 1555	.20	.22	.25
1S 1588	.20	.22	.25
1S 1885	.16	.18	.20
1S 2076	.20	.22	.25
1S 2093	.35	.40	.45
1S 2473	.16	.18	.20
1N 34	.12	.13	.15
1N 60	.12	.13	.15
10D 1	.30	.35	.40
10D 10	.45	.55	.60
V06B	.30	.35	.40

ZENERS

TYPE	25-UP	10-24	1-9
WZ 071	.20	.22	.25
WZ 075	.20	.22	.25
WZ 090	.20	.22	.25
WZ 120	.20	.22	.25
WZ 192	.20	.22	.25

MISC.

TYPE	25-UP	10-24	1-9
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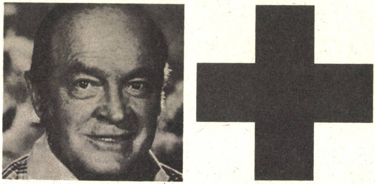

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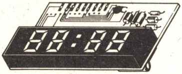

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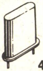

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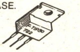

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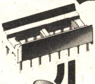

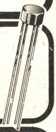

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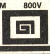

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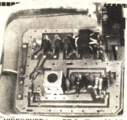

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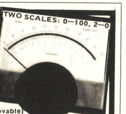

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□ 5649R	5.0V @ ma & +12V @ 250 ma	10.95	21.00

Limited Quantities!
5V 75 AMP REGULATED POWER SUPPLY
By POWERTEC—worth over $200. Can run a complete computer system! 16 x 15 x 4¾". Wt. 35 lbs.
□ **5642R** **$89**

DELTA Burglar ALARM

$24.50 MOTION DETECTOR

DELTA MOTION DETECTOR. This device detects any motion or movement for a minimum distance of 8-ft. The secret is in the ultra-complex custom LSI chip, which combines the latest in linear & digital circuitry. The device is completely self-contained, in a case 6 x 3 x 2¼", and operates from four "AA" NiCad batteries. Nothing else is needed, for the device to perform its basic function, motion detection. When motion or movement is detected, a "whoop" alarm is sounded. The MOTION DETECTOR is designed to provide either an audible or silent alarm. The silent alarm is controlled by a timer, which delays the alarm up to 30 seconds. The silent alarm activates a relay, whose contacts are brought out to plug, and will activate ANY device, such as siren, horn, tape recorder, telephone dialer, etc.,

The Motion Detector works on a CHANGE OF LIGHT. Any change of +5% or more, triggers the detector. Works within a range of 0.1 candlepower (almost dark), to 100 candlepower, (quite brite), a range of 1000 to 1. NO external light source is needed.

When left in a darkened or semi-darkened room, the Motion Detector acts as a fantastic FIRE ALARM. The light from a single match, anywhere in the room, triggers the alarm, so that the device becomes an intrusion alarm and fire alarm, all in one.

Delta No.	Description	Sale
□ 5611R	Complete motion detector kit (less batteries	$24.50
□ 1072R	Motion Detector Chip only, with data	8.95
□ 5611R	P.C. boards, set of 2	6.50
□		
□ 5636R	Battery charger for above	5.95
□ 5635R	Completely assembled kit, w/batteries & charger	69.50

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We have a limited number of 10½" reels of ⅛" computer tape These were used by a large computer manufacturer to test his tape drives. About half of what we have have been used once, and half are unused. These were all certified tapes. They average in length about 3300 feet. Ideal for loading your own cassettes with high quality computer tape. When you order 1 tape, you take your chance of getting new or used tape.

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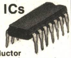

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7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	49¢
7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	69¢
74123	276-1817	99¢
74145	276-1828	1.19
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29
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4013	276-2413	89¢
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4020	276-2420	1.49
4021	276-2421	1.49
4023	276-2423	69¢
4027	276-2427	89¢
4028	276-2428	1.29
4046	276-2446	1.69
4049	276-2449	69¢
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4066	276-2466	99¢
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4543	276-2491	1.89

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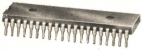

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8224 Clock and Generator Driver. 276-2524. .... **3.95**
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Under 450 nS Access Time

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276-2504. .... **12.95**

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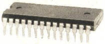

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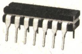

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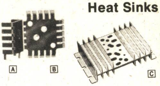
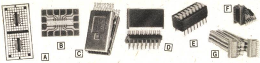
Heat Sinks



[A] **TO-220.** For PC board-mounted power semiconductors in TO-220 cases. Anodized aluminum. **276-1363** .... **79¢**
[B] **TO-3 Sink.** For PC or chassis mtg. **276-1364** **1.39**
[C] **Universal.** Mounts 2 devices, accepts 9 case styles. **276-1361** **2.69**

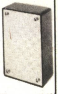
Top-Quality IC and PCB Accessories



[A] **PC Board.** Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹⁄₁₆". **276-151** **2.99**
[B] **PC Board.** Mounts single 14 or 16-pin IC or socket. **276-024** .... **Pkg. of 2/99¢**
[C] **16-Pin IC Test Clip. 276-1951** **3.99**
[D] **16-Pin DIP Header.** With snap-on cover. **276-1980** **1.29**
[E] **8-Rocker 16-Pin DIP Switch. 276-1301** **1.99**
[F] **Vertical 16-pin Socket.** For LED displays. **276-1986** **1.49**
[G] **16-Pin DIP Jumper Cable.** 18" long. **276-1976** **3.99**

Project Boxes

Aluminum Cover



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3¼x2⅛x1⅛". 270-230 .... **1.19**
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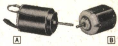
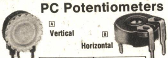
6¼x3¾x2". 270-627 .... **1.79**
7¾x4⅜x2⅜". 270-232 .... **2.49**

Miniature Hobby Motors



High-torque permanent magnet type. ¹⁄₁₆" dia. shaft.
[A] **12VDC.** 350mA. 2x¹³⁄₁₆". **273-210** .... **69¢**
[B] **6-9VDC.** 500mA. 1⅝x¾". **273-209** ..... **Pkg. of 2/99¢**

PC Potentiometers

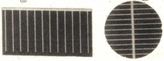


[A] Vertical — [B] Horizontal

	¼ W. (Fig. A)		⅛ W. (Fig. B)	
Ohms	Cat. No.	Ea.	Cat. No.	Ea.
500k	271-226	49¢	—	—
1k	271-227	49¢	271-333	39¢
5k	271-217	49¢	—	—
10k	271-218	49¢	271-335	39¢
25k	—	—	271-336	39¢
50k	271-219	49¢	—	—
100k	271-220	49¢	271-338	39¢
500k	271-221	49¢	—	—
1 Meg	271-229	49¢	—	—

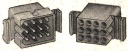
Solar Cells

4cm x 2cm [A] — 2¼" Dia. [B]



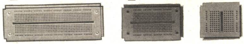
[A] **4cm x 2cm.** Silicon-type cell converts light to electrical power, delivering up to 100 mA at 0.5V. Use several in series-parallel for higher voltage or current. **276-120** **2.99**
[B] **2¼" Round.** Highly efficient silicon cell delivers up to 400 mA at 0.5V. Ideal for solar power projects, battery charging. **276-121** **5.99**

Molded Connectors



Molded nylon body. Each circuit rated 8A @ 250V. Standard .093" pin diameter.
[A] **4-Pin Male. 274-224** .... **99¢**
6-Pin Male. 274-226 .... **1.19**
9-Pin Male. 274-229 .... **1.39**
12-Pin Male. 274-232 .... **1.49**
[B] **4-Pin Female. 274-234** .... **99¢**
6-Pin Female. 274-236 .... **1.19**
9-Pin Female. 274-239 .... **1.39**
12-Pin Female. 274-242 .... **1.49**
2-Pin Male & Female. (Not Shown.) **274-222** .... **Pair 89¢**

IC Breadboard Sockets



Modular boards snap together and feature standard 0.3" center. Accept 22 through 30-gauge solid hookup wire.
[A] 550 connections in 2 bus strips of 40 tie points each with 47 rows of 5 connected tie points. 2⅛x6". **276-174** **9.95**
[B] 270 connections in 2 bus strips of 40 tie points each with 23 rows of 5 connected tie points. 2⅛x3⅝". **276-175** **5.95**
[C] **Mini-Socket.** 22 rows of 5 tie points each, plus 2 bus strips with 10 connections each. 2⅛x1⅞". **276-176.** Reg. $3.95 .... **Sale 2.99**

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[A] **Bezel with Lens.** Special high contrast filter for LED displays. 3⁹⁄₁₆x1" lens opening. **270-301.** Reg. $3.95 .... **Sale 3.49**
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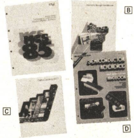
[C] **MA 1003 Clock Case.** For automotive clock modules. Accepts 3 pushbutton switches (not included). With bracket, blue lens. 3½x2⅛x2". **270-303** **5.95**

Computer Data Manuals and Semiconductor Handbook



[A] **Intel® 8080/8085 Programming Manual.** Handy reference for programming with Intel's assembly language. **62-1377** **3.95**
[B] **Intel Memory Design Handbook.** Explains use of Intel's memory components and support circuits in systems. **62-1378** **3.95**
[C] **Intel Data Catalog.** 928 pages of specifications on most of Intel's standard microcomputer-related products. **62-1379** **4.95**
[D] **Semiconductor Reference and Application Handbook.** Complete specs and applications for popular IC transistors, diodes. **276-4002** Reg. $1.95 ... **Sale 99¢**

MC14553 3-Digit BCD Counter IC

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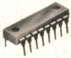

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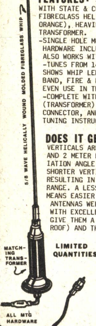
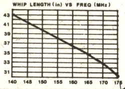


LIMITED QUANTITIES



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IC clock oscillator
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2SA564A	.29	.34	.39
2SA634	.35	.40	.45
2SA636	.80	.85	.90
2SA643	.30	.35	.40
2SA673	.30	.40	.45
2SA678	.40	.50	.55
2SA683	.40	.50	.55
2SA684	.40	.50	.55
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2SA733	.25	.27	.30
745R	3.60	3.80	4.20
2SB22	.45	.50	.55
2SB54	.30	.35	.40
2SB77	.30	.40	.45
2SB175	.35	.40	.45
2SB186	.20	.27	.30
2SB187	.20	.27	.30
2SB324	.25	.35	.40
2SB367	1.10	1.20	1.35
2SB405	.25	.30	.35
2SB407	.70	.85	.95
2SB463	1.00	1.05	1.15
2SB474	.70	.80	.90
2SB507	.70	.80	.90
2SB511	.70	.75	.85
2SB557	2.05	2.45	2.75
2SC183	.40	.50	.55
2SC184	.40	.50	.55
2SC372	.20	.27	.30
2SC373	.20	.27	.30
2SC380	.20	.27	.30
2SC382	.30	.40	.45
2SC387A	.30	.40	.45
2SC394	.25	.30	.35
2SC458	.20	.27	.30

	25-UP	10-24	1-9
2SC460	.45	.50	.55
2SC481	1.25	1.35	1.45
2SC482	1.25	1.35	1.45
2SC485	1.25	1.35	1.45
2SC495	.45	.55	.60
2SC509	.30	.40	.45
2SC517	2.90	3.10	3.25
2SC535	.30	.35	.40
2SC620	.45	.50	.55
2SC632A	.35	.40	.45
2SC634A	.40	.45	.50
2SC697A	3.20	3.50	3.90
2SC710	.20	.27	.30
2SC711	.20	.27	.30
2SC712	.20	.27	.30
2SC717	.35	.40	.45
2SC730	2.95	3.15	3.35
2SC732	.20	.25	.30
2SC733	.20	.25	.30
2SC734	.20	.25	.30
2SC735	.20	.25	.30
2SC756	1.45	1.75	1.95
2SC756A	2.00	2.10	2.20
2SC778	2.80	3.10	3.30
2SC781	1.95	2.15	2.45
2SC784	.30	.35	.40
2SC789	.75	.85	.95
2SC793	1.95	2.15	2.45
2SC799	1.95	2.15	2.45
2SC828	.20	.27	.30
2SC829	.20	.27	.30
2SC839	.30	.35	.40
2SC867A	4.00	4.25	4.50
2SC900	.20	.27	.30
2SC930	.20	.27	.30
2SC945	.20	.27	.30
2SC1000BL	.35	.40	.45
2SC1013	.45	.60	.65
2SC1014	.50	.60	.65
2SC1018	.70	.75	.85
2SC1030	1.80	2.05	2.35
2SC1056	4.50	4.70	4.90
2SC1060	.65	.75	.85
2SC1061	.70	.80	.90
2SC1096	.45	.50	.55

	25-UP	10-24	1-9
2SC1114	3.40	3.60	3.80
2SC1116A	3.20	3.45	3.80
2SC1124	.80	.85	.95
2SC1127	.80	.85	.95
2SC1162	.70	.75	.85
2SC1166	.25	.35	.40
2SC1172B	3.10	3.50	3.85
2SC1173	.50	.65	.70
2SC1177	10.90	12.40	13.80
2SC1209	.25	.35	.40
2SC1226	.50	.60	.70
2SC1226A	.50	.60	.70
2SC1237	1.70	1.90	2.15
2SC1239	2.10	2.65	2.85
2SC1306	1.25	1.65	1.85
2SC1307	2.15	2.65	2.85
2SC1318	.30	.40	.45
2SC1364	.30	.40	.45
2SC1383	.30	.40	.45
2SC1384	.30	.40	.45
2SC1424	2.75	2.85	2.95
2SC1448A	1.00	1.10	1.20
2SC1475	.65	.85	.95
2SC1509	.55	.60	.65
2SC1567A	.60	.65	.75
2SC1675	.25	.30	.35
2SC1678	1.25	1.40	1.55
2SC1687	.40	.45	.50
2SC1727	1.20	1.25	1.30
2SC1728	.90	.95	1.00
2SC1760	.85	1.00	1.10
2SC1775	.30	.35	.40
2SC1816	1.45	1.70	1.95
2SC1908	.25	.35	.40
2SC1909	2.00	2.55	2.75
2SC1945	4.40	4.90	5.50
2SC1957	.60	.70	.80
2SC1969	3.50	3.90	4.30
2SC1973	.60	.65	.70
2SC1974	1.25	1.65	1.85
2SC1975	1.25	1.65	1.85
2SC2009	.75	.80	.85
2SC2021	.55	.60	.65
2SC2028	.50	.60	.65
2SC2029	1.45	1.75	1.95

	25-UP	10-24	1-9
2SC2072	3.55	3.75	3.95
2SC2076	.45	.60	.65
2SC2091	.85	1.05	1.15
2SC2092	1.75	1.95	2.20
2SC2098	3.00	3.20	3.45
2SD72	.50	.60	.65
2SD91	1.30	1.40	1.55
2SD92	1.40	1.55	1.75
2SD180	1.55	1.75	1.95
2SD187	.30	.40	.45
2SD218	2.95	3.20	3.45
2SD234	.60	.70	.80
2SD235	.60	.70	.80
2SD261	.30	.35	.40
2SD287	2.50	2.65	2.85
2SD291	2.05	2.45	2.75
2SD313	.60	.65	.70
2SD315	.60	.70	.80
2SD325	.60	.65	.75
2SD330	.69	.79	.89
2SD356	.70	.75	.80
2SD358	.70	.80	.90
2SD359	.75	.85	.95
2SD427	1.75	1.95	2.20
2SD525	.70	1.05	1.15
2SD526	.60	.70	.80
2SK19	.45	.50	.55
2SK23	.80	.95	1.05
2SK30	.40	.45	.50
2SK33	.60	.65	.75
2SK34	.50	.55	.60
2SK41	.50	.55	.60
2SK55	.60	.65	.75
3SK22Y	1.60	1.70	1.80
3SK35	1.20	1.35	1.50
3SK37	1.70	2.00	2.30
3SK40	1.25	1.40	1.55
3SK41	1.25	1.40	1.55
3SK45	1.25	1.40	1.55
3SK48	3.30	3.40	3.70
3SK49	1.25	1.40	1.55
AN115	2.00	2.15	2.25
AN214Q	1.55	1.65	1.85
AN228	4.10	4.30	4.50
AN239	4.10	4.30	4.80

	25-UP	10-24	1-9
AN247P	2.40	2.60	2.90
AN274	1.50	1.70	1.90
AN313	4.20	4.40	4.60
AN315	1.75	1.95	2.20
BA511A	1.70	1.90	2.15
BA521	1.85	2.05	2.35
HA1151	1.45	1.70	1.85
HA1156	1.60	1.75	1.95
HA1306W	1.90	2.10	2.40
HA1322	2.40	2.60	2.90
HA1339	2.45	2.65	2.95
HA1339A	2.45	2.65	2.95
LA1222	2.10	2.30	2.50
LA3101	3.45	3.60	3.75
LA4031P	1.75	1.95	2.20
LA4032P	1.75	1.95	2.20
LA4220	2.25	2.40	2.55
LA4400	1.85	2.05	2.35
LD3141	1.70	1.80	1.90
M5115P	4.85	4.90	4.95
M51513L	1.95	2.15	2.45
MN3001	13.20	14.85	16.50
MN3002	9.25	10.40	11.55
MN3003	5.64	6.34	7.04
PLL01A	4.00	4.15	4.55
PLL02A	4.95	5.20	5.80
PLL03A	7.50	7.90	8.70
SG264A	7.00	7.40	7.80
SG609	4.10	4.30	4.50
SG613	5.20	5.40	5.95
SM5104	7.90	8.40	8.90
STK011	3.55	3.95	4.35
STK013	8.90	10.00	11.10
STK015	4.10	4.30	4.80
STK050	23.10	25.98	28.86
STK415	7.10	7.60	8.10
STK435	4.45	4.95	5.55
STK439	8.00	9.00	10.00
TA7045M	1.95	2.15	2.45
TA7055P	1.95	2.15	2.45
TA7060P	.85	1.05	1.15
TA7061P	.85	1.05	1.15
TA7062P	1.05	1.20	1.35
TA7063P	1.25	1.35	1.50
TA7074P	3.70	3.85	4.00

	25-UP	10-24	1-9
TA7089P	1.95	2.15	2.45
TA7092P	9.50	10.00	10.50
TA7120P	1.45	1.65	1.85
TA7139P	1.55	1.75	1.95
TA7153P	5.70	5.90	6.10
TA7203P	2.45	2.60	2.85
TA7204P	1.95	2.10	2.45
TA7205P	1.55	1.75	1.95
TA7214P	3.90	4.20	4.50
TA7310P	1.25	1.40	1.55
TA7607P	5.80	6.00	6.20
TA7609P	4.40	4.60	4.80
TBA8105H	1.85	2.05	2.35
TC5080P	4.80	5.00	5.60
TC5081P	2.90	3.10	3.30
TC5082P	3.30	3.45	3.80
UHIC001	4.90	5.10	5.60
UHIC002	4.90	5.10	5.60
UHIC003	4.90	5.10	5.60
UHIC004	4.90	5.10	5.60
UHIC005	4.90	5.10	5.60
UHIC006	4.90	5.10	5.60
UPC20C	2.00	2.40	2.70
UPC141C	2.30	2.40	2.50
UPC157A	3.25	3.45	3.65
UPC554C	1.60	1.70	1.80
UPC555H	1.60	1.70	1.80
UPC572C	3.70	4.10	3.69
UPC574C	.90	1.08	1.20
UPC575C2	1.25	1.40	1.55
UPC576	1.85	2.05	2.35
UPC592H2	.75	.85	.95
UPC1001H2	1.85	2.05	2.35
UPC1008C	4.85	5.15	5.75
UPC1020H	1.85	2.05	2.35
UPC1025	1.85	2.05	2.35
UPC1028	1.40	1.62	1.80
UPC1031H	2.52	2.74	2.98
UPC1032H	1.70	1.85	2.10
UPC1152H	2.90	3.10	3.30
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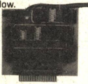
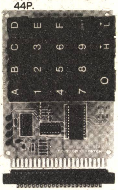


EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CAB40.

HEX ENCODED KEYBOARD [E.S.]

This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.

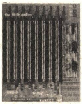


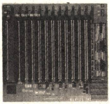
S-100 BUS ACTIVE TERMINATOR *

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A

9 AND 13 SLOT MOTHER BOARDS (WMC inc.)

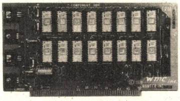
All traces are reflow solder covered and both sides are solder masked. The connectors used on these boards are the IMSAI™ type (.125" between pins, .250" between rows). Spacing between connectors is .750". All lines, except power and ground, have a passive RC network termination available. There is a kluge area available that will accept two 40 pin sockets and one 36 pin socket. The circuitry for supplying three separate regulated voltages to the kluge area is contained on the board. Part No. QMB-12 $40 bare, $105 kit, $120 assembled. Part No. QMB-9 $35 bare, $90 kit, $105 assembled.





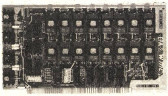
4K EPROM (WMC inc.)

This board is designed to operate with any speed or power 1702A. Addressable in 4K byte increments and can be configured to occupy either 2K or 4K segments. It can be populated one memory chip at a time. Bare board $30, board with parts $200, assembled $230. Part No. EPM-1



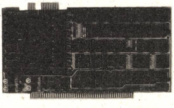
16K OR 32K EPROM (WMC inc.)

Designed to operate with any speed or power 2708 or single voltage (+5V) 2716. Addressable in 4K increments and can occupy multiples of 4K. It can be populated one memory chip at a time. Has bank addressing and Phantom Disable. The board comes with an exclusive software program that can be placed in a 2708 or 2716 that will, when used in conjunction with a RAM memory board, check out every line on the EPM-2. Bare board $30, board with parts with 2708 $455, assembled $485. Board with parts with 2716 $1,225, assembled $1,255. Part No. EPM-2



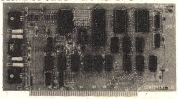
65K DYNAMIC RAM (PIICEON)

Main memory for microcomputers, intelligent terminals, business systems, medical systems, and OEM systems. • High density random access memory 48K bytes or 64K bytes • Fully buffered • S-100 bus compatible • Low power (dynamic memory) • Transparent refresh • Digital delay line techniques for reliable operation • Multiple boards allowed using hardware or software controlled bank select • "Phantom" signal for RAM/ROM overlap • All boards are fully tested prior to shipment. Operating System test and extensive bit pattern testing. • Works directly in 8080A processors or Z-80 environment at 2MHz • Currently used by industry • 1 year warranty. Only available assembled and tested with 48K $1,250 Part No. 48K, or with 65K $1,475 Part No. 65K



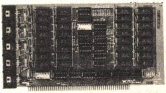
8080A CPU (With Eight Level Victor Interrupt Capability) (WMC inc.)

Uses the 8080A and the 8224 clock chip. The crystal frequency used is 18 MHz and the vector interrupt chip is the 8214. The board will function normally without the interrupt circuitry. When the interrupt circuitry is built up, the board will respond to eight levels of interrupts. Designed to be a plug-in replacement for the IMSAI CPU board and will work in other computers with the appropriate modifications made to the ribbon cable connector pin out from the front panel. The board will work in systems without a front panel if the system has a PROM board that simulates the functions of the front panel. Bare board $30, with parts $185, assembled $220. Part No. CPU-1



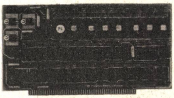
16K STATIC RAM (WMC inc.)

Operates with any speed or power 2114. All input and output lines are fully buffered. Addressable in 4K byte increments. If the system has a front panel, the board will allow itself to be protected. If there is no front panel, the board will not allow itself to be protected. The board has Bank Address capability, Phantom Disable, MWRITE, and selectable wait states. Bare board $30, board with parts $665. Part No. MEM2



8K EPROM (PIICEON)

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • On-board PROM programming • Address relocation of each 4K or memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.



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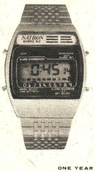

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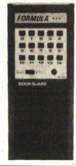

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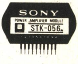

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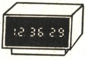
* 50/60 Hz Input
* 6 Digits Bright Orange Readouts



Kit includes plastic case, MM 5314 I.C. One set transistor drivers, P.C. Board, gas discharge displays, all other electronic parts and transformer. Catalog no. DC-8SP

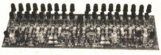
SPECIAL PRICE
$17.95 PER KIT

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose red). The power range is very large, from -30dB to +5dB. The Mark III indicator is applicable to 1 watt — 200 watts amplifier operating voltage is 3V — 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $17.50

9 STEPS LED LEVEL INDICATOR KIT



for most stereo amplifiers

This new project works as a pair of VU meter to indicate the output level of your amplifier from -20dB to +3dB. Kit includes all LED, transistors, electronic components, P.C. Board and instructions.

Easy to build and fun to see.

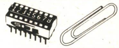
ONLY $12.50 EA.

COMPUTER GRADE CAPACITORS

All capacitors are Brand New U.S. made in standard size

6000MFD	50V	$2.60 EA.
9000MFD	50V	$3.25 EA.
11000MFD	35V	$3.20 EA.
14500MFD	40V	$3.40 EA.
23000MFD	20V	$3.00 EA.
58000MFD	20V	$3.20 EA.
100,000MFD	6V	$2.50 EA.

DIP SWITCHES

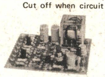


(On-Off Contacts)

4 positions	**$1.50**
5 positions	**$1.60**
6 positions	**$1.70**
7 positions	**$1.70**
8 positions	**$1.80**
10 positions	**$2.00**

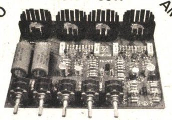
ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or overload to protect your amplifier as well as your speakers. A must for OCL circuits.



KIT FORM
$8.75 EA.

60W + 60W STEREO AMPLIFIER



COMPLETED UNIT—NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit

*Kit form **$37.50** — Assembled **$49.50 ea.**
Power transformer **$ 8.50 ea.**

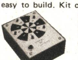
It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box. (case included) Uses a condensor microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft! With an LED indicator to signal the unit is on.

#FMM2

KIT FORM
$7.95

ELECTRONIC WHEEL OF FORTUNE KIT!

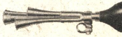
With 10 numbers split into black and white on dial. The LED turns when you hit the play switch, then it slows down and stops on one number. It sounds like a motor inside, but there is none. Lots of fun and easy to build. Kit comes with nice looking case, all electronic parts, P.C. Board and LEDs. Battery not included.



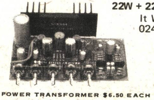
$12.50

AN AIR HORN!

Good for anything needing sound. This is not electronic, but we bought them with some other deals. They are all brand new in boxes. **$2.50 EA.**



22W + 22W STEREO HYBRID AMPLIFIER KIT



It Works in 12V D.C. As Well! Kit includes 1 PC SANYO STK-024 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 44 watts (22 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz. **$32.50 PER KIT**

POWER TRANSFORMER $6.50 EACH

CIRCLE 16 ON FREE INFORMATION CARD

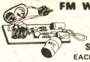
SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp

Kit Includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20—100,000 Hz. This amplifier has QUASI—Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω

ONLY $23.50 each

FM WIRELESS MIC KIT



This new model FM wireless MIC kit uses 3 high freq. transistors, works in the FM range (88-108 MHz). It transmits the sound wave fidelity clearly over long distances (up to 250 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

$6.95 EACH KIT

WE FOUND THE CASE FOR THE FM MIC!!

Small nice looking aluminum case size like a pack of cigarettes. It is an intercom. Audio amp inside with a mic jack, a mini toggle sw on top, can be used for many projects. We give you the circuit data as well.

VERY SPECIAL PRICE 2 for $4.99

63 KEYS ASC11 DECORDED COMPLETE KEYBOARD

by Honeywell

with dual color key tops, uses TMS 5000 decorder LSI. (schematic data included)

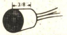
SPECIAL $56.50 NOT A KIT!

PROFESSIONAL CASE

for our 0-30V Power Supply. It is a nice looking metal cast case with giant 4" volt/amp meter; output blinding post and fuse holder, on/off switch and line cord! **ONLY $21.50 EA.**

CASE 030

Sub-Mini Size Condenser Microphone



$2.50 each

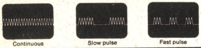
FET Transistor Built-in

MANY SOUND DECISIONS!

Solid state sound indicator operating voltage 6V DC 30μA. Small size approximately ¾" X 1¼".

Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)

$3.60 EACH



Continuous Slow pulse Fast pulse

POWER SUPPLY KIT

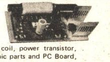
0-30V D.C. REGULATED

Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.

0-30 POWER SUPPLY **$10.50 each**

Transformer for Power Supply, 2 AMP 24V x 2 $6.50
30V DC Panel Meter $4.20

FLUORESCENT LIGHT DRIVER KIT



12V DC POWERED
Lights up 8～15 Watt Fluorescent Light Tubes
Ideal for camper, outdoor Auto or Boat

Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

ONLY $5.50 PER KIT

12V DC MINI RELAY

P.C. Board Solder Type

2AMP Contact SPDT $1.30 EA
2AMP Contact DPDT $1.75 EA
5AMP Contact 4PDT $2.20 EA

5 AMP 5VDC

3 Terminals Positive Voltage Regulator Hard to find! Fairchild 78HO5To-3 Package, Input 8.5 - 20V DC Output +5V DC 5AMP Load Regulation 1%.

Only $8.75 ea

HEAVY DUTY CLIP LEADS

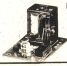
10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.

$1.85/pack

1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board
Supply Voltage 6～9V D.C.
SPECIAL PRICE $1.95 ea.

ELECTRONIC SWITCH KIT



CONDENSER TYPE

Touch On Touch Off uses 7473 I.C. and 12V relay
$5.50 each

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W X 2)

Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz — 20KHz.

Super Buy Only $18.50

AUTO ALARM KIT

The Crimefighter Auto Alarm is an electronic, self-controlled auto protection system, normally mounted within the glove box of an automobile. Two minutes after turning off the ignition, the alarm automatically turns itself "on". When auto is re-entered, the horn will sound after a 10-45 second entry delay. The automobile owner, by inserting the ignition key, will activate the alarm. Once activated, the alarm will sound for two minutes before automatically turning off. The alarm then resets and is ready to again protect the vehicle from unwanted entry.

FEATURES: Simple installation: 5 wires, Automatically turns on when auto is parked, Adjustable entry time, Extended exit time to allow for unrushed exit from vehicle, Numerous applications include protection of boats, campers, trailers, motorcycles, trucks, Cannot be deactivated by "hot wiring" an auto, Cannot be turned off without ignition key, Negative ground only.

ONLY $14.00 PER KIT

EECO THUMBWHEEL SWITCHES

BCD OUTPUT 0 - 9

10 positions 3 digits with end and each digit section is detatchable.

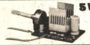
3 Digits only $5.00

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations
Batteries and ear phone included

Only $8.50

5W AUDIO AMP KIT

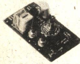


2 LM 380 with Volume Control
Power Supply 6～18V DC
only $5.00ea.

Sub Mini Size PANEL METER

500 UA
ONLY $1.20 ea

TIMER KIT



Time Controlled from 1-100sec.
Ideal to be used as timer delay unit for burglar alarm, photo service, and other purposes.
Max. loading 110V, 2 AMP.
Supply voltage 12-18V DC.

FT-80 ELECTRONIC IC TIMER **$11.50 each**

MINI-MINI TOGGLE SWITCH

Half size of subminl toggle switch rated 3 amp 125V AC contact

		1-9	10-99
MS 244	SPDT	1.00	0.90
MS 245	DPDT	1.20	1.10

LARGE QUANTITY AVAILABLE FOR OEM

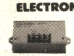
PANEL METER (D.C. Type)

Size 60MM X 66MM
White Face Type

$8.50 ea.

0-50 UA	0-30V
0-1MA	0-50V
0-5MA	0-100V
0-100MA	

ELECTRONIC ALARM SIREN



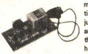
COMPLETE UNIT

Ideal for use as an Alarm Unit or hookup to your car back up to make a reverse indicator.
Light Output up to 130dB
Voltage Supply 6～12V **$7.50**

AU—999

CDS LIGHT CONTROL SWITCH KIT

High Sensitivity Darlington Circuit, operated with a 9V D.C. supply to control lights or use it for burglar alarm, shooting game, visitor buzzer, product counting, flash-light slave unit or automatic door opener and many more. The potentiometer is to adjust the sensitivity and the relay in the circuit can handle up to 200 watts.



$4.50 ea. kit

TRANSFORMERS

ALL 117 VOLT INPUT

30V	4AMP	$7.50 EA.
36V CT	3AMP	$6.50 EA.
48V CT	3AMP	$6.50 EA.
24V CT	3AMP	$6.50 EA.
24V CT	0.8AMP	$1.80 EA.
12V CT	0.8AMP	$1.80 EA.
12V CT	120MA	$1.25 EA.

SUBMINIATURES TOGGLE SWITCHES

SPDT	OnOff	$1.30 ea
DPDT	OnOff	$1.50 ea
3PDT	OnOff	$1.75 ea

Mini size Rocker Type Also available at the same price

SOUND ACTIVATED SWITCH

All parts completed on a PC Board
SCR will turn on relay, buzzer or trigger other circuit for 2～10 sec. (adjustable)
Ideal for use as door alarm, sound controlled toys and many other projects
Supply voltage 4.5V～9V D.C.
$1.75 ea./2 for $3.00

AC POWER SUPPLY

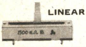
Wall Type Transformer

12V AC	Output	200MA	$2.75 EA.
16V CT AC	Output	100MA	$2.10 EA.
6V DC	Output	120MA	$1.90 EA.
12V DC	Output	100MA	$1.90 EA.

MINI SIZE REED RELAY

Approx. 1" square
SPST Normal Open
Contact rated 1AMP
Coil 6～12V DC
All brand new by AMF
3 for $2.00

LINEAR SLIDE POT 500KΩ SINGLE



Metal Case 3" Long
2 FOR $1.20

TEXTOOL 40 PINS D.I.P. ZERO INSERTION TEST SOCKET

It is perfectly suited for both hand test and burn in requirements. All brand new parts. $8.75 ea.

WIDE ANGLE PANEL METER

1¾" x ¾"
IMA Full Scale
(scale marks 0-100)
$1.50 each

PUSH-BUTTON SWITCH

N/Open Contact
Color: Red, White, Blue, Green, Black. 4/$1.00
N/Close also Available 50¢ ea.
LARGE QTY. AVAILABLE

DIGITAL ELECTRONIC LOCK KIT

for auto ignition, entry door, burglar alarm, etc.
4 Digits Programmable to Any Combination

$6.50 ea.
CMOS I.C. IN CIRCUIT

400A RELAY AND KEY PAD NOT INCLUDED

I.C. TEST CLIPS

Same as the E-Z clips
With 20" Long Leads
In Black and Red Colors
$2.75 per pair

HOUR INDICATOR

This unit is 1 5/8" long operating voltage 4V D.C. will tell you how many hours your circuit or machine has been in service up to 100 hours.

Limited Quantity ONLY $1.75 ea.

SOLID STATE ELECTRONIC BUZZER

Mini size 1" x ¾" x ¾"
Supply voltage 1.5V 12V
Ideal for Alarm or Tone Indicator
$1.50 each

BATTERY POWERED FLUORESCENT LANTERN

FEATURES

* Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
* 9" 6W cool/daylight miniature fluorescent tube.
* 6 X 1.5V UM-1 (size D) dry cell battery.
* Easy sliding door for changing batteries.
* Stainless reflector with wide angle increasing lumination of the lantern.

$9.60 EACH
MODEL 888-R

MINIMUM ORDER $10.00. California residents add 6% sales tax and 10% shipping.
Out of state add 15% of total purchase for shipping charges, out of USA and Overseas add 25% of total purchase. 1/79
SEND CHECK OR MONEY ORDER TO:

FORMULA INTERNATIONAL INC.

12603 CRENSHAW BOULEVARD • HAWTHORNE, CALIFORNIA 90250
For more information please call (213) 973-1921, (213) 679-5162
STORE HOURS 10-7 Monday - Saturday

master charge — your BANKAMERICARD welcome

SEND $1.00 FOR DETAILED CATALOG

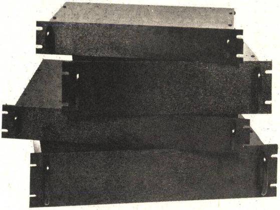
CIRCLE 70 ON FREE INFORMATION CARD

FEATURING... FROM
FORMULA International
BRIGHT NEW IDEAS!

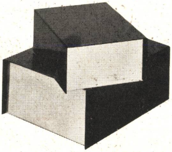
*TIMATRON™ Rack mount type cabinets!

All are of aluminum and machine made to very high-precision quality with sleek, black anodized finish. Front panels come blank and undrilled to allow you to make panels of your own design. For large quantity orders Formula International will silkscreen print and drill panel holes at a minimal extra charge.

SIZE	PRICE
19" (W) x 2½" (H) x 12" (D)	$36.85
19" (W) x 4" (H) x 12" (D)	45.25
19" (W) x 8" (H) x 20" (D)	72.00
16" (W) x 2½" (H) x 8" (D)	26.50
16" (W) x 4" (H) x 8" (D)	33.45
9½" (W) x 2½" (H) x 12" (D)	33.45
9½" (W) x 4" (H) x 12" (D)	24.50
9½" (W) x 4" (H) x 8" (D)	30.25



For Large Quantity Order and Special Sizes or colors please contact us direct.
***Distributor Inquiries Welcome!**



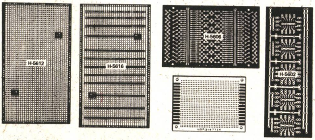
GENERAL PURPOSE INSTRUMENT BOXES . . .

All boxes are made of aluminum. Top is anodized black. Bottom is silver and comes with 4 rubber pedestals.

Part No.	Sizes	Price
FTA 421	4⅛" (W) x 1½" (H) x 2⅞" (D)	$2.10 ea.
FTA 452	4" (W) x 2" (H) x 5" (D)	3.50
FTA 572	5⅜" (W) x 2¾" (H) x 7" (D)	4.95

UNIVERSAL PROTOBOARDS "Circuit Fit"

All Boards are made of High Quality G10 Fiberglass and Phenolic. Pre-drilled in .042" diameter holes on 0.1" centers with tin plated copper eyelet and finger edge connectors (Single sided) to allow any kind of standard components to fit board.



Part No.	Size	Holes	Price Fiberglass	Price Phenolic
U.S.P. 723	2" x 2.8"	529	$ 1.27	$ .50
U.S.P. 724	2.8" x 3.7"	750	2.42	.80
U.S.P. 725	3.7" x 5.5"	1500	4.89	1.38
U.S.P. 728	7" x 9.6"	6240	19.50	10.40
H-5612	3½" x 6"			1.70
H-5616	3½" x 6"			1.70
H-5606	3¼" x 5"			1.50
H-5602	2½" x 6½"			1.50

MINIMUM ORDER $10.00. California residents add 6% sales tax and 10% shipping.
Out of state add 15% of total purchase for shipping charges, out of USA and overseas add 25% of total purchase.
SEND CHECK OR MONEY TO:

FORMULA INTERNATIONAL INC.
12603 CRENSHAW BOULEVARD • HAWTHORNE, CALIFORNIA 90250

For more information please call (213) 973-1921, (213) 679-5162 • STORE HOURS 10-7 Monday-Saturday

SEND $1.00 FOR DETAILED CATALOG

your BANKAMERICARD welcome

master charge THE INTERBANK CARD

CIRCLE 71 ON FREE INFORMATION CARD

KITS • KITS • KITS

NEW . . . PRE-DRILLED PCB's FOR ALL 100 SERIES KITS

*Perforated Boards **NOT INCLUDED** w/100 Series*

103 MINI-WINK NEON FLASHER. Random flash pattern. Interesting displays. 6 neon lamps. AC operated.

103 . . . . $2.95
103A (103 w/PCB) 4.60
103B (103 w/PCB, CASE) 6.85

110 ELECTRONIC WHOOPER SIREN. Powerful wailing sound. Dual oscillator circuit. Use with any alarm circuit. Battery not included.

110 . . . . $4.95
110A (110 w/PCB) 6.50
110B (110 w/PCB, CASE) 9.60

117 TUNABLE ELECTRONIC ORGAN. Tunable 7-note scale. Play sing-a-long favorites. Battery not included.

117 . . . . $6.95
117A (117 w/PCB) 8.90
117B (117 w/PCB, CASE) 12.00

120 SIREN/CODE OSCILLATOR. Loud, piercing alarm. Practice Morse code. Battery not included.

120 . . . . $4.20
120A (120 w/PCB) 5.55
120B (120 w/PCB, CASE) 8.65

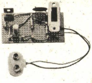
104 VARIABLE STROBE LIGHT. Great for parties and photography. Variable flash rate. AC operated.

104 . . . . $9.95
104A (104 w/PCB) 14.20
104B (104 w/PCB, CASE) 19.70

126 PROGRAMMABLE DOORBELL. Adjustable rate and pitch for 15 musical notes. Play favorite tunes. 6 IC's. Uses existing transformer and switch.

126 . . . . $16.95
126A (126 w/PCB) 23.70
126B (126 w/PCB, CASE) 29.20

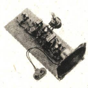
*Perforated Boards **NOT INCLUDED** w/100 Series*



109 AUTO/HOME BURGLAR ALARM. Use with car horn or models 110 or 124 sirens. Latching circuit. Battery not included.

109 . . . . $2.25
109A (109 w/PCB) 3.40
109B (109 w/PCB, CASE) . . 5.00

114 AUDIO AMPLIFIER. High sensitivity, high gain, use as intercom, PA amp, phone pick-up and others, push-pull output. Battery not included.

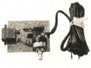


114 . . . . $6.35
114A (114 w/PCB) 8.90
114B (114 w/PCB, CASE) . 12.00

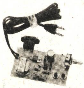
102 6/9 VOLT SUPPLY. 100mA. Battery eliminator, dual range output switch, neon pilot lamp. AC operated.

102 . . . . $3.95
102A (102 w/PCB) 5.30
102B (102 w/PCB, CASE) 7.25

119 MOTOR SPEED CONTROL. Adjust motor speed to suit application. SCR controlled, use as light dimmer. AC operated.



119 . . . . $3.95
119A (119 w/PCB) 5.50
119B (119 w/PCB, CASE) . . 7.75



123 ELECTRONIC TIMER. Turns appliances on and off, adjustable control, 2 minutes to 1 hour. 1 IC, AC operated.

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540 BINARY CLOCK. Handcraft tomorrow's timepiece today. Watch constantly changing patterns of LED's as they display Binary Time. This unique clock project enhances the learning of Digital Logic and the Binary Coding System, as well as offering a beautifully styled conversation piece.

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124A (124 w/PCB) 7.10
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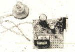

105 FISH CALLER. Clicking sound imitates distressed fish. Adjustable speed. Battery not included.

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105B (105 w/PCB, CASE) 5.70

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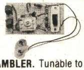

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CIRCLE 26 ON FREE INFORMATION CARD

SERVICE QUESTIONS

continued from page 106

BAD FLYBACK

The flyback circuit on this Sears 528. 4174 was out. I replaced it with an exact duplicate, but I still have problems! The output current is very high, the fuse blows, plus many other problems.—D. A., Aynor, SC.

I suggested that the technician run numerous stock tests, including using a Variac on the input, etc. He answered, "The whole problem was a bad *new* flyback! I found that the winding between 6 and 8 on the flyback was apparently causing all the problems. So I tried another new one, and it was bad too! I finally found one that worked. Thanks."

INTERMITTENT POPPING

I've got an intermittent in a Lafayette model LR-1500TA stereo receiver. At odd intervals it emits loud pops and bangs, then stops. This may happen again in half an hour, or a month later! Have you ever run across anything like this before?—G. W., N. Miami, FL.

Often! From your letter, the blast of sound seems to be in both channels at once. And this means the problem should be in something *common* to both channels—the DC power supply. I notice this supply has two regulators, one on the +70.7-volt line and one on the +12.45-volt line. Check both these regulators out for possible thermal transistors, or bad solder joints on any of the components. Tap around these circuits to see if this makes things act up.

(Feedback: "Wow! I found the problem. There was a bad solder joint on R253, the 15K resistor in the emitter circuit of Q1, the +70.7-volt regulator. When I tapped it the thing went crazy! Thanks.")

WHERE DOES THE BLUE WIRE GO?

Thanks for the hint you gave me on the Quasar TS-914 chassis. A little choke was open on the high voltage rectifier! Now, I've got one other question. While putting the chassis back, I managed to pull the blue wire loose. This wire goes to the intensity control, but where does it go from there? There's also a gray shielded cable on the control.—J. W., Griffith, IN.

Welcome to the club! I've pulled many leads off and had some troubles too. The shielded lead to the intensity control comes from the cathode of the V16A, the first color IF, and the shield is grounded. Therefore, the blue wire should go from the slider (center terminal) of the control to the grid of the 6DX8 tube, which is the same tube that is used as the first color IF amplifier, pin 8. **R-E**

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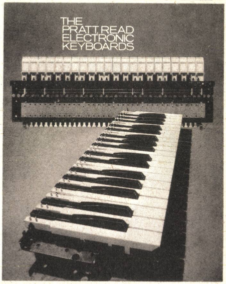

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Cassette I/O (Tarbell) 29.95
8K Eprom (2708) 21.95
1702 Eprom Board 30.00
2708/2716 Eprom (Ithaca) 34.95
2708/2716 Eprom (WMC) 30.00
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Vector 8800 Proto 19.95
Vector 8803 11 slot MB 29.95
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9 Slot MotherBoard (WMC) 29.95
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ATTENTION KIM USERS

KIMSAI-expansion to S-100 ... 125.00 Kit/165.00
KIMSI to KIM Connector 5.75/pair
KIM 1 6502 Single Board Computer 179.00
KIM 1 Power Supply 59.95
KIM Memory Plus - (consists of 8K Ram, 8K 2716 Eprom, Programmer, I/O etc.) 245.00
KIM SOFTWARE
• Please package (cassette) 12 games 16.95
• Help Editor package (cassette) 16.95
• Help Mailing List pkg. (cassette) 16.95
• Help Info Ret... pkg. (cassette) 16.95
• Microchess (cassette) 16.95
• Microaid Assembly/Disassem/Editor 27.95
• Microaid Source Listing (cassette) 27.95
• Tiny Basic for KIM (paper tape) 10.95

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1771-01 8" & Minifloppy 27.95
uPd372 Nec Floppy 49.95
1781 Dual Floppy 39.95
1791 Dual Floppy 99.00

ATTENTION PET USERS

BETSI-pet expansion to S100 ... 105.00 Kit/160.00
PET Connector Kit. Includes (4) Connectors for memory expansion, IEEE 488 I/O, cassette I/O and parallel user port ... 7.95 set
Video Buffer (converts to Std. Video) 29.95
Petunia (Music Board) 29.95
Combo (Video & Petunia) 49.95
Beeper (signals tape load) 24.95

ATTENTION APPLE II USERS

Apple II w/16K $1045.00
16K Upgrade Kit 89.95
Floppy Disk II w/Interface 595.00
Floppy Disk II 495.00
Firmware Card 180.00
Video Monitor (B/W) 205.00
Printer Centronics P-1 w/cont 695.00
Printer Centronics P-1 .... 475.00
Printer Centr. 779 w/cont 1445.00
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Parallel I/O Card 180.00
Communications I/O Card 180.00
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2716 Eprom Burner w/adapt 99.95
Apple II to MFE tape I/O 197.50
Coresident Assembler Cass 19.95

Heuristics Robot Car 249.00
Heuristics 20A Speechlab 189.00
Dow Jones Stock Quote Pkg 25.00
AJ A242 Coupler 325.00
I/O to transmit over existing wiring .... 189.00 A/T
★Trencom therman 40 col. printer $345.00
Apple I/O for Trencom 60.00
★Lower case adapter 49.95

All Shipments FCM or UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Mastercharge/Bankamericard/COD accepted w/25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Same day shipment. Add 25 cents for Data.

Retail pricing may vary from Mail Order Pricing. All pricing subject to change without notice.

STATIC RAM HEADQUARTERS

	1-24	25-99	100
21L02 450ns.	1.30	1.25	1.15
21L02 250ns.	1.59	1.55	1.45
2102	1.25	1.15	1.10
2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
2101-1	2.90	2.70	2.55
2114-250ns.	9.95	7.95	7.25
2114-450ns.	7.95	6.95	4.75
TMS 4044/5257 250ns.	9.95	8.95	7.95
TMS 4044/5257 450ns.	7.95	7.25	5.95
EMM4200A	9.75	8.75	7.95
EMM4402	7.95	7.25	6.25
EMM4804	12.50	11.50	9.95
5101C-E	7.95	7.95	7.25
upd410 (4200)	10.95	10.25	9.25
AMD9140/41	10.95	10.25	5.25
AMD9130/31	12.95	11.95	10.25
FSC 460/4616K CCD Only $18.95 Each			
1101	1.95	1.75	1.25
P2125/93425 (45 ns.)	8.95	7.35	7.25
6508 1K x 1 CMOS	7.95	7.95	7.25
6518 1K x 1 CMOS	7.95	7.95	7.25
74S189 64 bit Ram	3.95	3.25	2.50
8155 I/O w/Ram 21.95			
2147 Low Power 4K Static 14.95 ea.			

WAVEFORM GENERATORS

8038 Function Gen. 3.95
MC4024 VCO 2.45
LM566 VCO 1.75
XR2206 Function Generator 5.25

CHARGE COUPLED DEVICES

16K CCD - First time offered Fairchild 460 CCD 16K Memory (now you can experiment with CCD technology at a reasonable price. 17 page Application note supplied with each order. Quantity limited)
$18.95 each (reg. 43.00)

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Microprocessor Timebases TV Game

Frequency	Price	Frequency	Price
1.0MHz	$5.85	6.0MHz	$ 4.95
1.8432	4.95	6.144	4.95
2.0MHz	5.85	6.5536	4.95
2.01MHz	2.95	10.0MHz	4.95
2.097152MHz	5.85	13.0MHz	4.95
2.4576MHz	5.85	14.31818	4.95
3.579545MHz	1.50	18.0MHz	4.95
4.0MHz	4.95	18.432MHz	4.95
4.194304MHz	5.95	20.0MHz	4.95
4.91520MHz	5.95	22.1184MHz	5.95
5.0MHz	4.95	27.0MHz	5.95
5.0688	4.95	36.0MHz	5.95
5.7143MHz	5.95	48.0MHz	5.95
		100KC	12.95

DISPLAYS/OPTO

DL 704/707/CC/CA .300 .... 1.25
FND359 CC .357 .... .95
FND 500/507/CC/CA .500 .... 1.35
FND 503/510 CC/CA .500 .... .95
FND 800/807 CC/CA .800 .... 2.50
Bowmar 9 digit bubble .... .99
FSC 8024 4 digit CC .800 .... 4.95
HP7340 HEX Display 19.95
HP 5082-7340 HEX 19.95
HP 5082-7300 HEX 19.95
TIL 305 5x7 Array 5.25
TIL 306, 308, 309, 7 seg 8.95
TIL 311 HEX display 12.95
MA 1003 12 auto clock 17.95
MA 1002, 1010 4 digit clock module 9.95
Bezel for above 4.95
NSN 373/374 dual CC/CA .300 .... 2.20
NSN 583/584 dual CC/CA .500 .... 2.60
NSN 783/784 dual CC/CA .700 .... 3.00
4N25 Opto Isolater 1.10
MCT 2 Opto Isolater .... .89
4N33 Darlington ISOL 1.75
Red Led's .185 Dia. 5/1.00
Green/Yellow 4/1.00
HP 5082/7731 7 seq. .... .90
MAN IOA 9.95

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22 Pin S/T Sockets .... .10
1488 or 1489 RS232 .... .95
1408L8 .... 4/19.95
8T26 .... 2.25
ICL 7208 .... 13.95
ICL 7107 3½ Dig. A/D 11.95
ICL 8211 Volt. Ref 1.95
LM1877 Dual 2W Amp 1.95
LM390 Batt. Op. Audio Amp 1.75
LM1830 Fluid Detector 1.95
LM1850 Ground Fault IC 1.75
LM1800 PLL FM Stereo 2.25
LM1820 AM Radio 1.25
LM2917 Freq to Voltage 2.25
MK5014 Calculator IC .... .95
75451/52/53 .... 10/2.50
8T20 Bidirector one shot 3.49
MH0025 or MH0026 Mos Driver 2.50
8223 Prom 2.95
LF13508 JFET Anlog Multi 8 ch. 8.95
MCM14505 64 bit CMOS RAM 8.95
LF356H JFET Input OP Amp 1.25
MC68488 IEE I/O 19.95
MC10147 128 x 1 ECL RAM 9.95
2114L 450ns. 1K x 4 .... 100 @ 4.75 ea.

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Compucolor II	Contact sales desk	
Exidy	Contact sales desk	
Soroc IQ 140	1495.00	1495.00
TEI PT208	4599.00	4699.00
TEI MCS122	550.00	562.00
Cromemco Z-2	536.00	551.00
Cromemco SYS III	5499.00	5561.00
Centronics P-1	475.00	487.00
Centronics S-1	525.00	539.00
TI 810 Printer	1895.00	1925.00
Persci 277	1195.00	1230.00
Shugart 800/801	495.00	512.00
Pertec FD200	299.00	319.00
Commodore PET	775.00	795.00
Horizon I	1439.00	1479.00
North Star	599.00	617.00
ADM 3 Assem.	829.95	865.00
Soroc IQ 120	895.00	945.00
Teletype Model 43	1199.00	1230.00
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Oliver 2708/16 Programr.	275.00	288.00
Houston Digital Plotter	999.00	999.00
Pennywhistle Modem	139.95	139.95
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Okidata 22 w/TF RS232	2705.00	2810.00
MEK 6800 D2 Kit	235.00	Same
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Intercept Jr 6100	281.00	Same
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Rockwell AIM	375.00	Same
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TWX: 910-595-1565

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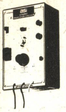
CIRCLE 5 ON FREE INFORMATION CARD

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

Trans-Check $29.95 ea.

Custom Cables & Jumpers

NEW NEW

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS
25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95

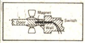
Solar Cells 2x2cm

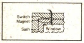
- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 **$1.95 ea. or 3/$5.00**

Magnetically Activated Switch





The 9250-0002 is a single pole normally closed switch. When the magnet is engaged, the circuit is open. This switch is only suitable for use in non-magnetic doors and windows.

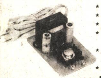
#9250-0002 **2/$1.00**

AC Wall Transformer

Ideal for use with clocks, power supplies or any other type of AC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95

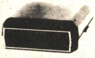
Regulated Power Supply



- ⋆ Uses LM 309K
- ⋆ Heat sink provided
- ⋆ P.C. board construction
- ⋆ Provides a solid 1 amp @ 5V
- ⋆ Includes components, hardware and instructions
- ⋆ Sizes: 3-1/2" x 5" x 2" high

JE200 $14.95

INSTRUMENT/CLOCK CASE



This case is an injection molded unit that is ideal for use such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	1.95
UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS		
M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
ROM'S		
2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14,95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
TMS2516 (2716)	16K*	EPROM(Intel 2716)	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

NEW!! IN STOCK... POWERACE
ALL-CIRCUIT EVALUATORS WITH POWER

- 1680 solderless, plug-in tie points...will hold up to 18 14-pin DIP's.
- Breadboard elements accept all DIP sizes...including RTL, DTL, TTL and CMOS devices. TO-5's and discretes with leads up to .032''dia.
- All connections to/from switches, indicators, power supplies and meters are made via solderless, plug-in, tie-point blocks on control panels.
- Interconnect with any solid 20 to 30 AWG wire.
- Breadboard elements are mounted on ground planes...ideal for high-frequency and high-speed/low-noise circuits.
- Short-circuit-proof fused power supplies.
- Operate on 110 to 130 VAC at 60 Hz
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping.
- All models are 7.5'' wide 11.5'' deep and 4.0'' high (rear) 0.75'' high (front) and weigh approx. 2.5 lbs.

POWERACE 101 -General purpose model for prototyping all types of circuit.
#923101 **$ 84.95**

POWERACE 102 -Complete digit prototyping lab with built-in logic probe
#923102 **$114.95**

POWERACE 103 -Triple-output power supply for prototyping both linear and digit circuits.
#923103 **$124.95**

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv. 1Va. 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage - 0-1000V/
AC Voltage: 0-1000V
Freq. Response: 50-400 HZ
DC/AC Current: 0-100mA
Resistance: 0-10 meg ohm
Size: 6.4" x 4.4" x 2"

Model 2800
$99.95
Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

CONTINENTAL SPECIALTIES CORPORATION

- 20 Hz-100 MHz Range
- .6" LED Display
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- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator
use power from car battery **Model 100 — CLA $3.95**
Charger/Eliminator
use 110 V AC **Model 100 — CAI $9.95**

New CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz. and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-IPC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax
Spec Sheets – 25¢
1979 Catalog Available—Send 41¢ stamp

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a division of JAMES ELECTRONICS of California

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ADVERTISED PRICES GOOD THRU MARCH

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method .....Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate ....300 Baud.
Data Format ....Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies ...2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies ..Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity ....−46 dbm accoustically coupled.
Transmit Level ....−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance ...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface ....EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements ....120 VAC, single phase, 10 Watts.
Physical ....All components mount on a single 5" by 9" printed circuit board. All components included.
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

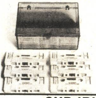
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) **for only $139.95**

COMPUTER CASSETTES



- ⋆ 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- ⋆ PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ⋆ ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6
$14.95
(Case and 6 Cassettes)

SUP 'R' MOD II
UHF Channel 33 TV Interface Unit Kit

Wide Band B/W or Color System

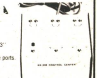
- ★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
- ★ MOD II is pretuned to Channel 33 (UHF).
- ★ Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

RS-232 CONTROL CENTER

Plug in your modem, computer prom programmer, terminal, printer, etc. and selectively control data flow.

- Same Contour as "Pennywhistle 103"
- Totally self-contained
- Includes 2 master ports and 3 slave ports.



PART NO. RS-232CC $89.95 kit only

CASSETTE CONTROLLER

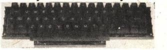
Ideal for use with the TRS 80 and others.

"Plug/Jack interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100
$29.50

63-Key Unencoded Keyboard



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

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SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
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CD4017	1.19	CD4050	.49	MC14506	.75
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CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
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74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
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LM308CN/H	1.00	LM340T-24	1.25	LM748N/H	.39
LM309H	1.10	LM358N	1.00	LM1310N	2.95
LM309K	1.25	LM370N	1.95	LM1458CN/H	.59
LM310CN	1.15	LM373N	3.25	LM1488N	1.95
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LM320K-15	1.35	NE531H/V	3.95	LM3900N(3401)	.49
LM320K-18	1.35	NE536T	6.00	LM3905N	.89
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LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE561B	5.00	75453CN	.39
LM320T-24	1.25	NE562B	5.00	75454CN	.39
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LM324N	1.80	NE566CN	1.75	75492CN	.89
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LM340K-6	1.35	LM703CN/H	.69	RC4136	1.25
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LM340K-12	1.35			RC4194	5.95
LM340K-15	1.35			RC4195	4.49

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74LS01	.23	74LS51	.23	74LS139	.69
74LS02	.23	74LS54	.23	74LS151	.69
74LS03	.23	74LS55	.23	74LS155	.69
74LS04	.29	74LS73	.35	74LS157	.69
74LS05	.29	74LS74	.35	74LS160	.89
74LS08	.23	74LS75	.49	74LS161	.89
74LS09	.29	74LS76	.35	74LS162	.89
74LS10	.23	74LS78	.39	74LS163	.89
74LS11	.60	74LS83	.75	74LS164	.99
74LS13	.49	74LS85	.99	74LS175	.79
74LS14	.99	74LS86	.35	74LS181	2.49
74LS15	.29	74LS90	.49	74LS190	.89
74LS20	.23	74LS92	.59	74LS191	.89
74LS21	.29	74LS93	.59	74LS192	.89
74LS22	.29	74LS95	.79	74LS193	.89
74LS26	.29	74LS96	.89	74LS194	.89
74LS27	.29	74LS107	.35	74LS195	.89
74LS28	.29	74LS109	.35	74LS253	.79
74LS30	.23	74LS112	.35	74LS257	.69
74LS32	.29	74LS123	.99	74LS258	1.39
74LS37	.35	74LS125	.69	74LS260	.55
74LS40	.29	74LS132	.79	74LS279	.59
74LS42	.69	74LS136	.39	74LS367	.59
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a division of JAMES ELECTRONICS of California

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
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- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing)
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JE900 $39.95

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XC22G	green	4/$1		XC526G	green	4/$1
XC22Y	yellow	4/$1		XC526Y	yellow	4/$1
.170" dia.				XC526C	clear	4/$1
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.085" dia.				.190" dia.		
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INCLUDES CONNECTOR

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MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL33B	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
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MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
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MC4016(74416)	7.50
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14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61
SOLDERTAIL STANDARD (TIN)							
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				
SOLDERTAIL STANDARD (GOLD)							
8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45
WIRE WRAP SOCKETS (GOLD) LEVEL #3							
8 pin WW	.39	.38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 PCS	1.75
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

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California Residents – Add 6% Sales Tax

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a division of JAMES ELECTRONICS of California

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TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block	5.95
LD110/111	3½ Digit A/D Converter Set	25.00/set

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
2/99¢

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$3.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

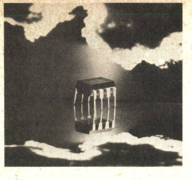
C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CIRCLE 8 ON FREE INFORMATION CARD



THE NEW HOBBY WORLD CATALOG

Your source for factory prime, professional quality equipment. Computers, add-on boards, IC's, sockets, resistors, supplies, tools, test equipment, books, and more. Shop your buy list at Hobby World. You'll find what you want, and at a solid savings. For example, look at this month's specials:

NEW FROM CALIFORNIA COMPUTER SYSTEMS!
16K STATIC RAM KIT, MODEL XVI.
IEEE S-100 compatible, requires only +5 Volts. 450 ns, fully buffered. Bank switching capability, Phantom Line, wait state, addressable in 4K blocks.
HOBBY WORLD PRICE ONLY $265 KIT, $27 BARE BOARD

16K MEMORY ADD-ON FOR APPLE, TRS-80 OR EXIDY SORCERER
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- General Communication
- Industry
- Marine VHF
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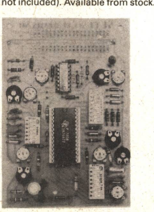
CIRCLE 32 ON FREE INFORMATION CARD

BULLET ELECTRONICS

The SE-01 is a kit that contains all the parts needed to build a programmable sound effects generator. Designed around the new **Texas Instruments 76447 Sound Chip**, the board provides banks of Mini DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot and Envelope Controls. Another IC is used to implement an Adjustable Pulse Generator. Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" by 5" plated PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains**, or an almost infinite number of **other sounds**, the unit has a multitude of applications. The **$16.95** price includes Assembly Manual, Programming Charts, and 76477 Chip specifications (speaker not included). Available from stock.



MC1469R POSITIVE VOLTAGE REGULATOR
½ AMP COMPLETE SPECS AND APPLICATIONS SHOW HOW TO BUILD FIXED OR VARIABLE POWER SUPPLIES FROM 3 TO 30VDC. DRIVE EXTERNAL SERIES PASS FOR CURRENT TO 20 AMPS!
1.25 EA.
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HOUSE #

IL-1 OPTO ISOLATORS
BY LITRONIX 6 PIN DIP STANDARD PINOUT LED-TRANSISTOR COMBINATION.
50¢
WHILE THEY LAST!

HOUSE # PNP POWER
TO-3
150 WATTS
80 VCEO
10 AMPS
IDENTICAL TO 2N3790 **1.00**

WIREWRAP Wire
30 Gauge
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4.50

NEW ITEMS:
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2N5583 High Freq. Amp 1 Watt @ 1.5 GHZ! TO-5 Case style, House # **50¢**
MFC4000B ¼ Watt Audio Amp 4 pin plastic pack **50¢**
HI10103 100V 3A SCR Ultra sensitive gate drives from TTL. TO-220 **55¢**
HI03SS 50V 3A Triac Sensitive Gate TO-5 **40¢**

MPF131 N-CHANNEL DUAL GATE MOSFET
50¢
DESIGNED FOR AMPLIFIER AND MIXER APPLICATIONS TO 200 MHZ. PLASTIC CASE. UNITS ARE HOUSE NUMBERED **WITH SPECS.**

CAPACITORS
SMALL SIZE!
2200 MFD @ 16 VDC RADIAL
3/1.00
500 MFD @ 35VDC
5/1.00 AXIAL
220 MFD @ 25VDC
7/1.00 AXIAL
1 MFD @ 20VDC DISC CERAMIC
15/1.00

.022	@	100VDC Mylar	8/1.00
.22	@	50VDC Mylar	6/1.00
1.5mfd	@	400VDC Mylar	4/1.00
.1mfd	@	35V Tant Axial	6/1.00
.47mfd	@	35V Tant Axial	6/1.00
2.2mfd	@	35V Tant Axial	5/1.00
22mfd	@	20V Dip Tant	4/1.00
33mfd	@	10V Dip Tant	4/1.00

YOU'VE SEEN IT ON QUALITY STEREO GEAR
SUPER DEAL!
BLACK INSERT
BRUSHED CHROME
ALCO
7/8" hole to hole
DPDT Toggle
ALCO CST-022
.3A @ 125V
.49

FANTASTIC SOUND EFFECTS CHIP
THIS 28 PIN MARVEL CONTAINS A LOW FREQUENCY OSCILLATOR, VCO, NOISE OSCILLATOR, ONE SHOT, MIXER AND ENVELOPE CONTROL. WITH 8 PAGE MANUAL. 5 to 9VDC **3.95**

HOUSE #
LM3900 QUAD NORTON AMP
WE BOUGHT A LARGE QUANTITY OF THESE HOUSE NUMBERED PARTS AT A BARGAIN PRICE THAT ALLOWS US TO SELL THEM AT A LOW, LOW **39¢**

FND510 69¢
COMMON ANODE READOUT ½" CHARACTER
LIMIT 24 PER CUSTOMER!

LED'S JUMBO: RED **5/.89**
GREEN **4/.89**
MEDIUM: RED **.15**
GREEN **.16**
YELLOW **.16**
MINI: RED **.10**
1.5V 10-30 ma

MC1351P FM-IF AMP AND DISCRIMINATOR
USED IN FM & TV SOUND CIRCUITS. REQUIRES MINIMUM EXTERNAL COMPONENTS. 14 PIN DIP. DIRECT REPLACEMENT FOR HEPC 6060, ECG 748 and MANY OTHERS. HOUSE #
WITH SPECS **50¢**

739 FAIRCHILD
DUAL LOW NOISE AUDIO PRE-AMPLIFIER
89¢ 2/1.69

EMITTER RESISTORS
HARD TO FIND VALUES!
.1 ohm @ 5W
.25 ohm @ 5W
YOUR CHOICE...
7/1.00

25A
100V
SCR
1.95
Perfect for battery chargers, switching supplies, crowbars, etc.

MJ900 - MJ1000
COMPLIMENTARY PNP, NPN **DARLINGTON POWER TRANSISTORS.** 8 AMPS. WE SUPPLY A SCHEMATIC TO BUILD A HIGH POWER (35W) LOW DISTORTION AUDIO AMP WITH ONLY ONE ADDITIONAL TRANSISTOR AND A DOZEN INEXPENSIVE COMPONENTS! TO-3 CASE STYLE **BUY A PAIR FOR**
$3.00!

ALL COMPONENTS 100% GUARANTEED

CA3011	WIDEBAND IF AMP w/specs	50¢
2N3569	NPN EPOXY 1W	6/1.00
741	OP AMP 8 PIN DIP	5/1.00
723	VOLTAGE REG. 14 PIN DIP	50¢
MPS6530	NPN HOUSE #	8/1.00
725	OP AMP LOW NOISE HOUSE #	99¢
7815	15V 1A REGULATOR HOUSE #	69¢
2N4343	P CHANNEL J FET	4/1.00
2N6111	PNP MED PWR 40W TO-220	3/1.00
2N6028	PROGRAMMABLE UNIJUNCTION w/specs	50¢
TRIAC	200V 8A UNMARKED	3/1.00

Diodes

1N4003	200V 1A	15/1.00
1N4006	800V 1A	12/1.00
1N270	Germanium Diode	8/1.00
1N38A	Germanium Diode	10/100
1N4148	Cut & Bent for PC Board Insertion	100/1.25

UNMARKED POWER DIODES with cathode bands. Guaranteed to be at **least** 400PIV @ 1A. 100% Good parts. Epoxy case. **25/1.00**

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- TEX RESIDENTS ADD 5% TAX
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PHONE ORDERS ACCEPTED ON VISA & MC

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FREQUENCY COUNTER KIT

Outstanding Performance

CT-50 Incredible Price $89^{95}

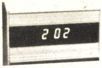
The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on.

Order your today!

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadin	15.95

CAR CLOCK



The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock

12/24 hour clock in a beautiful plastic case features: 6 jumbo RED LEDS, high accuracy (1 min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
DM-1 dimmer adapter	2.50

PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens, typically 20 mv at 150 mHz. Specify ÷ 10 or ÷ 100 ratio.

PS-1B, 600 mHz prescaler	$59.95
PS-1BK, 600 mHz prescaler kit	49.95

OP-AMP SPECIAL

741 mini dip	12/$2.00
B1-FET, mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all: 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches.

Complete kit, less case (not available) DC-9	$34.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 kit	$12.95
FM-3 wired and tested	16.95

CLOCK KITS

our Best Seller your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).

Clock kit, 12/24 hour, DC-5	$22.95
Clock with 10 min. ID timer, 12/24 hour, DC-10	27.95
Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

Hard to find PARTS

LINEAR ICs	
301	$ .35
324	1.50
380	1.25
380-8	.75
555	.45
556	.85
566	1.15
567	1.25
1458	.50
3900	.50
CMOS ICs	
4011	.20
4013	.35
4046	1.85
4049	.40
4518	1.25
5369	1.75
TRANSISTORS	
2N3904 type	10/1.00
2N3906 type	10/1.00
NPN 30W Pwr	3/1.00
PNP 30W Pwr	3/1.00
2N3055	.60
UJT 2N2646 type	3/2.00
FET MPF102 type	3/2.00
UHF 2N5179 type	3/2.00
MRF-238 RF	11.95
SOCKETS	
8 pin	10/2.00
14 pin	10/2.00
16 pin	10/2.00
24 pin	4/2.00
28 pin	4/2.00
40 pin	3/2.00

REGULATORS	
78MG	$1.25
723	.50
309K	.85
7805	.85
78L05	.25
7905	1.25
7812	.85
7912	1.25
7815	.85
TTL ICs	
74S00	.35
7447	.65
7475	.50
7490	.50
74196TI	1.35
SPECIAL ICs	
11C90	13.50
10116	1.25
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Micro red	8/1.00
BiPolar	.75
FERRITE BEADS	
With info, specs	15/1.00
6 hole balun	5/1.00

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit $2.95 FM-2 kit $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.

Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.

Complete kit, BL-1 $2.95

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Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!

Complete kit, VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.

Complete kit, TD-1 $5.95

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An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.

Complete kit, WL-1 $6.95

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Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5V at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.

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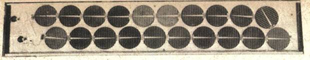

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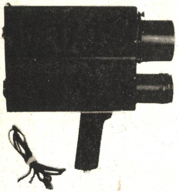

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4001 –	.18	4019 –	.37	4049 –	.35	74C74 –	.45
4002 –	.18	4020 –	.90	4050 –	.35	74C83 –	1.15
4006 –	.95	4021 –	.90	4053 –	1.10	74C86 –	.40
4007 –	.18	4022 –	.90	4055 –	1.25	74C93 –	.75
4009 –	.37	4023 –	.18	4066 –	.70	74C151	1.40
4010 –	.37	4024 –	.75	4071 –	.18	74C160	1.05
4011 –	.18	4025 –	.18	4076 –	.97	74C161	1.05
4012 –	.18	4027 –	.37	4520 –	.70	74C174	1.05
4013 –	.29	4028 –	.80	74C00 –	.22	74C175	1.05
4014 –	.75	4029 –	.95	74C02 –	.22	74C192	1.20
4015 –	.75	4030 –	.33	74C04 –	.24	74C193	1.20
4016 –	.29	4035 –	.97	74C08 –	.22	74C901	.48
4017 –	.90	4042 –	.65	74C10 –	.27	74C902	.48
4018 –	.90	4046 –	1.35	74C73 –	.65	74C914	1.70

1488-RS232 INTERFACE –	$1.40	UPD410-1 4K STAT. RAM –	9.95
1489-RS232 INTERFACE –	1.25	4116 –	11.50
2509-TRI STATE STAT. SR –	1.35	5280/2107B 4K DYN RAM –	3.40
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2518-HEX 32 BIT SR –	2.20	5204 4K PROM –	4.95
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MK4008P –	1.95	8212 –	2.25
2101-1 254 x 4 STATIC –	2.45	8216 –	2.25
2111-1 256 x 4 STATIC –	3.45	8224 –	2.95
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DL-704 .3" C.C. $ .85
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HP3400 .8"CC $1.95
HP3405 .8"CA $1.95

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2N2646 UJT .... $ .45
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100	.06	.14	.30	.80	3.70	5.00
200	.07	.20	.35	1.15	4.25	6.50
400	.09	.25	.50	1.40	6.50	9.50
600	.11	.30	.70	1.80	8.50	12.50
800	.15	.35	.90	2.30	10.50	16.50
1000	.20	.45	1.10	2.75	12.50	20.00

SAD 1024 a REDICON 1024 stage analog "Bucket Brigade" shift register. $14.95

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340K-12,15 or 24V. $1.10
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7400 –	.15	7446 –	.68	74153 –	.61
7401 –	.15	7447 –	.58	74154 –	.94
7402 –	.15	7448 –	.68	74155 –	.58
7403 –	.15	7450 –	.18	74157 –	.55
7404 –	.18	7472 –	.25	74158 –	.65
7405 –	.18	7473 –	.28	74161 –	.55
7406 –	.22	7474 –	.28	74162 –	.80
7407 –	.24	7475 –	.45	74163 –	.55
7408 –	.18	7476 –	.30	74164 –	.85
7409 –	.18	7480 –	.31	74165 –	.95
7410 –	.15	7483 –	.65	74170 –	1.68
7411 –	.18	7485 –	.87	74173 –	1.20
7412 –	.18	7486 –	.28	74174 –	.95
7413 –	.36	7489 –	1.25	74175 –	.85
7414 –	.60	7490 –	.42	74176 –	.75
7416 –	.22	7491 –	.58	74177 –	.75
7417 –	.25	7492 –	.43	74180 –	.65
7420 –	.18	7493 –	.43	74181 –	1.90
7425 –	.30	7494 –	.67	74190 –	1.00
7426 –	.22	7495 –	.65	74191 –	.85
7427 –	.28	7496 –	.65	74192 –	.79
7430 –	.18	7497 –	.90	74193 –	.79
7432 –	.22	74107 –	.28	74194 –	.80
7437 –	.22	74121 –	.30	74195 –	.50
7438 –	.22	74122 –	.40	74196 –	.86
7440 –	.18	74123 –	.45	74197 –	.80
7441 –	.70	74125 –	.40	74279 –	.55
7442 –	.45	74126 –	.40	74298 –	.90
7445 –	.65	74148 –	1.10	74368 –	.62
		74150 –	1.00	74393 –	1.25
		74151 –	.61	74325 –	1.50

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200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

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8 PIN .17   24 PIN .35
14 PIN .20   28 PIN .40
16 PIN .22   40 PIN .60
18 PIN .25

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.47UF	35V	5/$1.00	10UF	10V	$ .25
.68UF	35V	5/$1.00	22UF	25V	$ .40
1UF	35V	5/$1.00	15UF	35V	3/$1.00
2.2 UF	20V	5/$1.00	30UF	6V	5/$1.00
3.3UF	20V	4/$1.00	47UF	20V	$ .35
4.7UF	15V	5/$1.00	68 UF	15V	$ .50

74LS SERIES

74LS00 –	.23	74LS132 –	.70
74LS02 –	.23	74LS138 –	.70
74LS03 –	.23	74LS139 –	.70
74LS04 –	.25	74LS151 –	.65
74LS05 –	.25	74LS153 –	.65
74LS08 –	.25	74LS155 –	.68
74LS09 –	.25	74LS156 –	.68
74LS10 –	.23	74LS157 –	.68
74LS11 –	.23	74LS160 –	.90
74LS13 –	.44	74LS161 –	.90
74LS14 –	.80	74LS162 –	.90
74LS15 –	.23	74LS163 –	.90
74LS20 –	.23	74LS168 –	1.05
74LS21 –	.23	74LS169 –	1.05
74LS22 –	.23	74LS170 –	1.40
74LS26 –	.29	74LS173 –	1.20
74LS27 –	.29	74LS174 –	1.00
74LS28 –	.29	74LS175 –	1.00
74LS30 –	.23	74LS181 –	2.20
74LS32 –	.29	74LS190 –	1.10
74LS37 –	.28	74LS191 –	1.10
74LS38 –	.28	74LS192 –	.88
74LS40 –	.23	74LS193 –	1.10
74LS42 –	.65	74LS195 –	.80
74LS47 –	.73	74LS196 –	.80
74LS51 –	.25	74LS197 –	.80
74LS54 –	.25	74LS241 –	2.50
74LS73 –	.35	74LS257 –	.88
74LS74 –	.34	74LS258 –	.88
74LS75 –	.50	74LS259 –	1.35
74LS76 –	.35	74LS265 –	.30
74LS85 –	.90	74LS266 –	.39
74LS86 –	.35	74LS279 –	.70
74LS90 –	.50	74LS290 –	.60
74LS92 –	.50	74LS293 –	.58
74LS93 –	.50	74LS365 –	.60
74LS109 –	.35	74LS366 –	.60
74LS112 –	.35	74LS368 –	.60
74LS113 –	.35	74LS375 –	.70
74LS114 –	.35	74LS386 –	.35
74LS125 –	.45	74LS390 –	1.45
74LS126 –	.45	74LS670 –	2.00

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LM307 –	.30
LM 308 –	.75
LM 311 –	.75
LM 318 –	1.20
LM 324 –	.70
LM 339 –	1.10
LM 358 –	.70
LM 370 –	1.15
LM 377 –	1.60
LM 380 –	.95
LM 382 –	1.25
LM386 –	.80
LM 387 –	1.25
LM 537 –	2.50
LM 553 –	2.50
LM 555 –	.39
LM 556 –	.85
NE540L –	2.25
560 –	2.00
565 –	.95
566 –	1.10
567 –	1.10
703 –	.90
733H –	.75
592H –	.95
709 –	.25
710 –	.35
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1458 –	.50
3900 –	.40
8038CC –	3.90
791 –	1.95
LF356H –	1.20

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	.70	1.30	.40	.50	1.20
200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

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TTL		74LS00		74C00			
7400	.21	74LS00	.28	74C00N	.25	75452	.61
7401	.18	74LS01	.28	74C02N	.25	75453	.61
7402	.18	74LS02	.28	74C04N	.27	75454	.61
7403	.18	74LS03	.28	74C08N	.25	75491	.81
7404	.17	74LS04	.29	74C10N	.25	75492	.87
7405	.21	74LS05	.29	74C14N	.90	75493	1.09
7406	.25	74LS08	.29	74C20N	.25	75494	1.19
7407	.25	74LS09	.29	74C30N	.25	MC1488N	.90
7408	.21	74LS10	.28	74C32N	.25	MC1489N	.90
7409	.21	74LS11	.28	74C42N	.98	**LINEAR**	
7410	.17	74LS12	.28	74C48N	1.28	CA3046	.75
7411	.21	74LS13	.47	74C73N	.72	CA3086	.50
7412	.21	74LS14	1.02	74C74N	.48	LF351N	.76
7413	.25	74LS15	.28	74C76N	.72	LF356N	1.20
7414	.89	74LS20	.28	74C83N	1.38	LF357N	1.20
7416	.25	74LS21	.28	74C85N	1.38	LF13741	.76
7417	.25	74LS22	.28	74C86N	.40	LM301AN	.44
7420	.21	74LS26	.33	74C90N	.98	LM307N	.64
7421	.25	74LS27	.33	74C93N	.98	LM308N	1.00
7423	.35	74LS28	.33	74C95N	1.10	LM311N	.90
7425	.35	74LS30	.28	74C107N	.70	LM317T	3.00
7426	.25	74LS32	.33	74C150N	2.90	LM317MP	1.90
7427	.33	74LS33	.33	74C151N	1.90	LM318N	2.70
7428	.28	74LS37	.33	74C154N	2.90	LM320MP-5	1.30
7430	.21	74LS38	.33	74C157N	1.90	LM320MP-6	1.30
7432	.25	74LS40	.28	74C160N	1.18	LM320MP-8	1.30
7433	.30	74LS42	.67	74C161N	1.18	LM320MP-9	1.30
7437	.25	74LS47	.79	74C162N	1.18	LM320MP-12	1.30
7438	.25	74LS48	.77	74C163N	1.18	LM320MP-15	1.30
7439	.50	74LS51	.28	74C164N	1.10	LM320MP-18	1.30
7440	.21	74LS54	.28	74C165N	1.10	LM320MP-18	1.30
7442	.53	74LS55	.28	74C173N	1.30	LM320MP-24	1.30
7445	.70	74LS73	.39	74C174N	1.16	LM323K	7.50
7446	.70	74LS74	.39	74C175N	1.16	LM324N	.72
7447	.70	74LS75	.53	74C192N	1.38	LM325N	2.70
7448	.70	74LS76	.39	74C193N	1.38	LM326N	2.70
7450	.21	74LS78	.39	74C195N	1.10	LM327N	2.70
7451	.21	74LS83	.79	74C221N	1.90	LM339N	1.15
7453	.21	74LS85	.98	80C95N	.48	LM340T-5	1.25
7454	.21	74LS86	.39	80C96N	.48	LM340T-6	1.25
7460	.21	74LS90	.57	80C97N	.48	LM340T-8	1.25
7470	.30	74LS92	.57	80C98N	.48	LM340T-10	1.25
7472	.30	74LS93	.57	74C901N	.48	LM340T-12	1.25
7473	.30	74LS95	.88	74C902N	.48	LM240T-15	1.25
7474	.30	74LS96	.88	74C909N	1.78	LM340T-18	1.25
7475	.49	74LS107	.39	74C926N	7.80	LM340T-24	1.25
7476	.32	74LS109	.39	**4000 CMOS**		LM341P-5	.98
7480	.70	74LS112	.39	4000	.23	LM341P-6	.98
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7493	.44	74LS139	.73	4011	.23	LM349N	1.60
7494	.70	74LS151	.75	4012	.23	LM358N	.72
7495	.70	74LS153	.75	4013	.40	LM386	.85
7496	.70	74LS154	1.10	4014	.96	LM1310N	.84
74100	1.28	74LS155	.75	4015	.96	LM1800N	.94
74107	.30	74LS156	.75	4016	.40	LM1801N	1.70
74109	.33	74LS157	.75	4017	1.05	LM1812N	4.80
74116	1.26	74LS158	.75	4018	1.05	LM1830N	1.30
74121	.35	74LS160	1.02	4019	.40	LM1889N	2.00
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74126	.40	74LS164	1.02	4023	.23	LM3089N	1.30
74128	.48	74LS168	1.14	4024	.84	LM3900N	.88
74132	.70	74LS169	1.14	4025	.23	LM3905N	1.40
74141	.88	74LS170	1.73	4027	.40	LM3909N	.61
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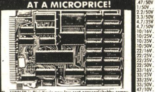
After reading through the features, we are confident that you will agree that there is no question that the MA1023 "Programmable" clock module is truly unique.

And to enhance the MA1023 kit even more, Digi-Key is introducing a specially designed switching panel kit complete with standoffs and hardware for "sandwich mounting" with the MA1023 module. But if your preference or needs dictate remote mounting of the switching panel — no problem. You will still enjoy the straight forward one-to-one pin connection offered by the Digi-Key switching panel kit and MA1023 module. Furthermore, the printed circuit board that provides the basis for the switching panel incorporates circuitry that will speed and simplify completion of the project. In addition to the simplicity offered by the Digi-Key switching panel, the low profile, light touch, panasonic switches utilized will add quality and professionalism to your finished product.

DIGI-KEY SWITCHING PANEL KIT MA1023P

(Shown assembled and "sandwich mounted" to MA1023 Clock Module)

The "NIBBLER" A MICROCOMPUTER AT A MICROPRICE!



The NIBBLER is Digi-Key's new low cost personal/hobby computer. Based on National Semiconductor's SC/MP-11 microprocessor, the NIBBLER includes 4K NIBL Basic in ROM and 2K of RAM. The NIBBLER requires 5 volts at ½ amp providing 110 baud serial ASCII I/O which is easily interfaced with a CRT or Teletype. And our low price of $149.95 is for an assembled and tested system! Software/Hardware manual included with NIBBLER available separately for $5.00.

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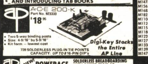

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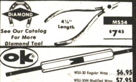

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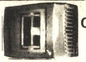

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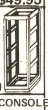

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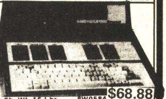

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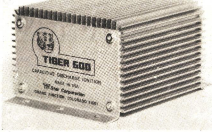

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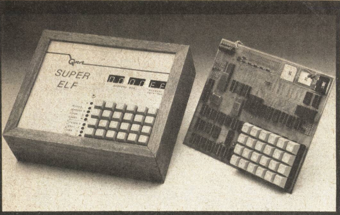

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An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

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This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed** ($12.00 value). EPROM can be used for the monitor and Tiny Basic or other purposes.

A IK Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability, and video graphics driver with blinking cursor. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The **Power Supply** for the Super Expansion Board is a 5 amp supply with + 8v ± 18v + 12v − 5v. Regulated voltages are ±5v & +12v $29.95. −12 volt optional. Deluxe version includes the case at $39.95.

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7402N	.17
7404N	.19
7409N	.23
7410N	.17
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.17
7474N	.29
7475N	.49
7485N	.88
7489N	2.00
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.29
74121N	.34
74123N	.59
74125N	.39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.25
74LS02N	.25
74LS04N	.25
74LS05N	.25
74LS08N	.25
74LS10N	.25
74LS13N	.40
74LS14N	.90
74LS20N	.25
74LS22N	.25
74LS28N	.41
74LS30N	.25
74LS33N	.39
74LS38N	.30
74LS74N	.35
74LS75N	.47
74LS90N	.51
74LS93N	.51
74LS95N	1.89
74LS107N	.35
74LS112N	.35
74LS113N	.35
74LS132N	.72
74LS136N	.35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	.91
74LS163N	.91
74LS174N	.95
74LS190N	1.06
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LM309H	1.15
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LM320K-15	1.35
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LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.10
LM340K-8	1.10
LM340K-12	1.10
LM340K-15	1.10
LM340K-24	1.10
LM340T-5	1.10
LM340T-8	1.10
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LM340T-15	1.10
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CD4011	.21
CD4012	.21
CD4013	.36
CD4014	.86
CD4015	.86
CD4016	.36
CD4017	.94
CD4018	.94
CD4019	.21
CD4020	1.02
CD4021	1.02
CD4022	.86
CD4023	.21
CD4024	.75
CD4025	.21
CD4026	1.51
CD4027	.36
CD4028	.79
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CD4030	.21
CD4035	1.02
CD4040	1.02
CD4042	.71
CD4043	.63
CD4044	.63
CD4046	1.67
CD4049	.36
CD4050	.36
CD4051	1.13
CD4060	1.42
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CD4071	.21
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8096	.65
8097	.65
8098	.65
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8	.15	22	.30
14	.18	24	.35
16	.20	28	.42
18	.27	36	.58
20	.29	40	.57

3 level wire wrap gold.
14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

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16	.33	28	1.00
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AY5-1014	7.50
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HD0165-5	6.95

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Red	.55	.47
Black	.55	.47

Keyer 8043 14.50
comp. w/spec./sock.

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2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
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DL747/750	CA/CC	.600	1.95
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8000		55V	2.50
9400		65V	3.00
10000		20V	2.50
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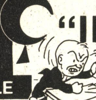

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☐ 15-LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (#2635)	2.49	30 for 2.50
☐ 100-POLYSTYRENE CAPS, asst'd values, voltage, hi-Q (#2729)	2.49	200 for 2.50
☐ 50-THERMISTORS, resistors that change with temp (#4089)	2.49	100 for 2.50
☐ 20-BRIDGES, untested, 2, 4, 6, amp, full wave (#4022)	2.49	40 for 2.50
☐ 15-MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (#3619)	2.49	30 for 2.50
☐ 150-QUARTER WATTERS, resistors, metal film, marked (#3413)	2.49	300 for 2.50
☐ 100-PLASTIC TRANSISTORS, untested, TO-92 (#2604)	2.49	200 for 2.50
☐ 200-PREFORMED RESISTORS, ¼, ½, 1W, marked, asst'd (#2608)	2.49	400 for 2.50
☐ 150-PRECISION RESISTORS, ½, 1W, 1%, 2% marked (#2428)	2.49	300 for 2.50
☐ 60-DIPPED MYLARS, shiny finish, asst'd values (#2597)	2.49	120 for 2.50
☐ 30-VOLUME CONTROLS, audio, linear, asst'd values (#2421)	2.49	60 for 2.50
☐ 300-SILICON SIGNAL DIODES, micro, glass, zeners tool 50% yield (#2628)	2.49	600 for 2.50
☐ 15-CLOCK-CALCULATOR, may include MM5378, MM5375 (#5638)	2.49	30 for 2.50
☐ 10-PUSH SWITCHES, push-to-break, spst, alarms (#5289)	2.49	20 for 2.50
☐ 12-MICROPROCESSORS, and support IC's. (#5639)	2.49	24 for 2.50
☐ 150-GLASS ZENERS, 400 MW, untested, better than 50% yield (#2740)	2.49	300 for 2.50
☐ 75-CARBOFILM RESISTORS, ¼, ½ watt, 5 & 10%, marked, asst's (#3534)	2.49	150 for 2.50
☐ 250-UNMARKED CAPACITORS, polystyrene, molded, pop values (#3805)	2.49	500 for 2.50
☐ 100-1N4148/914 SWITCHING DIODES, 50%+ yield. Untested! (#2418)	2.49	200 for 2.50
☐ 30-PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (#3345)	2.49	60 for 2.50
☐ 15-SLIDE VOLUME CONTROLS, asst'd values, duals, singles (#3057)	2.49	30 for 2.50
☐ 75-4" CABLE TIES, plastic, like "Ty-wrap" (#5218)	2.49	150 for 2.50
☐ 10-CRYSTALS, may include CB, Ham & more (#3250)	2.49	20 for 2.50
☐ 100-TERMINAL STRIPS, from 2 lugs up (#3136)	2.49	200 for 2.50
☐ 30-NE-2NEON LAMPS, all 100% good (#2613)	2.49	60 for 2.50
☐ 40-ft. SHIELDED CABLE, 1 cond, mikes, phonos, (#3577)	2.49	80 ft. for 2.50
☐ 3-SOUND TRIGGERS, sound triggers scr w/amp (#3625)	2.49	6 for 2.50
☐ 10-CB CRYSTALS, for phase lock loop, HAM, HC/18 (#5050)	2.49	20 for 2.50
☐ 50-4 LAYER SHOCKLEY DIODES, Asst. pop. voltages (#1072)	2.49	100 for 2.50
☐ 75-SN7400 TTL ICs, untested 50%+ yield, pop types (#2415)	2.49	150 for 2.50
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☐ 75-LINEARS, OP AMPS, untested 50%+ yield, amps-dips-minidips (#2416)	2.49	150 for 2.50
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☐ 3-MM5262 2K DYNAMIC RAM, specify type (#3459)	1.29	6 for 1.30
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☐ SN7437	.25	.26
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☐ SN7450	.20	.21
☐ SN7455	.20	.21
☐ SN7464	.20	.21

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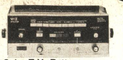

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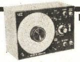

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Reg. $249.95 OUR PRICE **$175.00**

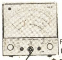
- Complete with 5 socket adapters including in-line type.
- Easy to use, compact, rugged ABS plastic case.
- 3 meter design permits all three guns of color pix tube to be tested simultaneously
- Effective cathode-emission restorer adds life to weak pix tubes.

Ruggedized Color Bar Generator
MODEL **WR-538A**

- Die-cast aluminium case, tough-glass PC board shock mounted pattern switch, oper. temp. 5 F to 145 F.
- 100% digital I.C. crystal control.
- Color bars with markers, dots, crosshatch, super-pulse and sync control, 3 line AC cord.

Reg. $130.00 OUR PRICE **$75.00**

Senior VoltOhmyst
MODEL **WV-98C**



- 3 color meter face and panel for positive function identification peak to peak and rms scales.
- Meter electronically protected against overload.
- Response to 3 MHz, 11MΩ input resistance
- Die-cast aluminum case
- Easy-to-read 6½" (16.4 cm) mirror-scale meter
- Measures from 0.2Ω, 0.01 VDC, 0.05 VAC to 1000MΩ, 1500 volts DC and AC, ± 3% accuracy all functions

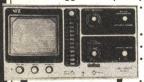
Reg. $139.00 OUR PRICE **$118.00**

Master VoltOhmyst
MODEL **WV-510A**

Reg. $169 OUR PRICE **$143.50**

- Excellent stability.
- Battery or AC operation.
- Measures from 0.01 milliampere to 1.5 amperes in 7 ranges.
- Measures from 0.2 ohms to 1000 megohms in 7 ranges.
- Measures from 0.01 volt to 1500 volts DC in 8 ranges.
- Measures from 0.2 to 1500 rms AC volts in 7 ranges.
- Measures peak-to-peak voltages of complex waveforms from 0.5 to 4200 volts in 7 ranges
- 21-megohm resistance on all DC ranges, ± 3% F.S. accuracy all function.
- Supplied with DC/AC Ohms probe with flexible shielded input cable (BNC connector), and current test loads.
- Mirror scale meter—movement electrically protected against burnout.

15 MHz. Trigger Sweep Scope WO-527A



- Freq. resp. DC to 15 MHz (−3 dB) sensitivity 10 mV/cm. to 20V in 11 ranges. Rise time 23 n. sec. Horz. Osc Freq. DC to 1MHz.
- Trigger mode normal or auto freq. resp. DC to 30 MHz.
- Calibrated time base 0.5μ sec. to 0.5 sec., 10 ranges
- Preset TVV and TVH plus special TV line selector to display single line of TV video frame
- Times 10 sweep Mag. advanced I. C. circuitry thruout full shield 8 x 10 cm CRT with P-31 Phos

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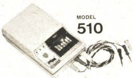
B&K PRECISION Transistor Testers

MODEL **520B**

Industrial Transistor Tester

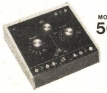
- Now with HI/LO Drive
- Works in-circuit when others won't
- Identifies all three transistor leads
- Random lead connection
- Audibly and visually indicates GOOD transistor
- Automatic NPN/PNP determination
- Positive Si/Ge identification
- Tests diodes, SCR's, FET's, and Darlingtons
- CSA approved version available



MODEL **510**

Portable Transistor Tester

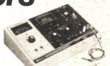
- Fast GO/NO-GO in-circuit transistor testing
- Fast and thorough GOOD/BAD out-of-circuit testing
- Tests FET's and SCR's in-circuit or out-of-circuit
- Connect any test clip to any component lead
- Gives positive emitter-base-collector identification in LO drive—positive base identification in HI drive
- Light-Emitting Diodes indicate NPN-OK or PNP-OK
- Pocket-size—Over 100 hours of testing from single set of "AA" cells
- Digital stability—no adjustments; nothing to go out of calibration
- Includes carrying case and leads



MODEL **501A**

Semiconductor Curve Tracer

- Display characteristic curves for all semiconductor devices on your scope
- Measure breakdown voltage non-destructively
- Identify unknown devices
- Complete with FP-5 probe



MODEL **530**

Lab-Quality Semiconductor Tester...

- Measure f_T of bipolar transistors up to 1500 MHz
- Nondestructive testing of transistor and diode breakdown voltages
- Measures transistor beta or FET g_m
- Measures all transistor breakdown and leakage parameters
- Fast testing of transistors, FET's, and SCR's—in or out-of-circuit
- Base diagrams are not required
- No biasing information required
- Identifies all leads of transistors and SCR's
- Automatic identification of PNP/NPN types and N- or P-channel FET's

New from B&K... and we have them at discount prices!

MODEL **820**

New Portable Digital Capacitance Meter

- Measures capacitance from 0.1pF to 1 Farad
- Resolves to 0.1pF
- 10 ranges for accuracy and resolution
- 4 digit easy-to-read LED display
- 0.5% accuracy
- Special lead insertion jacks or banana jacks
- Fuse protected
- Uses either rechargeable or disposable batteries
- Overrange indication

MODEL **3010**

New Low Distortion Function Generator

- Generates sine, square and triangle waveforms
- Variable amplitude and fixed TTL square-wave outputs
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 0.1 Hz to 100 kHz
- Variable DC offset for engineering applications
- VCO external input for sweep-frequency tests

MODEL **3020**

New Sweep/Function Generator

- Four instruments in one package—sweep generator, function generator, pulse generator, tone-burst generator
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs
- Three-step attenuator plus vernier control
- Internal linear and log sweeps
- Tone-burst output is front-panel or externally programmable

B&K PRECISION

SUPER SPECIAL

New 30MHz Frequency Counter

Model 1827

- 30MHz reading guaranteed, 50MHz typical
- Full 6-digit display with range switch allows 8-digit accuracy

Reg. $120.00
$59.95

MODEL **110** Compact VOM

SPECIFICATIONS: DC Volts: 0-2.5, 10, 50, 250, 1000V DC Current: 0.05, (250mV), 25, 250mA DC Accuracy: ±3% F.S. AC Volts: 0-10, 50, 250, 500, 1000 AC Accuracy: ±4% F.S. Resistance: 0-1k, 100k, 1M Meter: 20,000 VDC, 10,000 VAC. Battery Req.: 1.5V "AA" battery Optional Acc.: LC10 Case Size (HWD): 12.5 x 8.75 x 3.75 cm (5 x 3.5 x 1.5") Weight: .35kg (.4 lb.)

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2.7	11	47	200	820	3600	15K	62K	270K
3.0	12	51	220	910	3900	16K	68K	300K
3.3	13	56	240	1000	4300	18K	75K	330K
3.6	15	62	270	1100	4700	20K	82K	360K
3.9	16	68	300	1200	5100	22K	91K	390K
4.3	18	75	330	1300	5600	24K	100K	430K
4.7	20	82	360	1500	6200	27K	110K	470K
5.1	22	91	390	1600	6800	30K	120K	510K
5.6	24	100	430	1800	7500	33K	130K	560K
6.2	27	110	470	2000	8200	36K	150K	620K
6.8	30	120	510	2200	9100	39K	160K	680K
7.5	33	130	560	2400	10K	43K	180K	750K
8.2	36	150	620	2700	11K	47K	200K	820K
9.1	39	160	680	3000	12K	51K	220K	910K
10	43	180	750	3300	13K	56K	240K	1.0M

HIGH QUALITY··LOW OEM PRICE

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RESISTOR ASSORTMENT with metal cabinet

100ea 1/4W 5%

3.9	6.8	12	18	27	39
56	82	120	180	270	390
560	820	1.2K	1.8K	2.7K	3.9K
5.6K	8.2K	12K	18K	27K	39K
56K	68K	100K	120K	180K	270K
390K	560K	820K	1.2M	1.8M	2.7M

$54.95

ELEC-TROL REED RELAY 12 vdc 440 Ω coil dpst n.o.

.3 1.1" .4

PICTURE IS APPROXIMATION, RELAY HAS FOUR PINS ON ONE END AND TWO ON OTHER, PINS ARE SPACED .1" X 1". 1/2A CONTACTS.

79¢ ea. 10 - $6

RCA to220 8A, 600V TRIAC ea. 99¢ ten-$9.50 $89/c

BISTABLE RELAY
SPDT 6VDC 200 ohm coils
1 amp, 20 watt DC contacts
Long life (1x10E+9) oper.
High speed (500 Hz)
Hermetically sealed
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OPTO ISOLATOR FCD820 6PIN DIP
WILL DRIVE A TTL GATE WITH TEN MA LED CURRENT
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High quality, marked computer grade signal diodes. Leads trimmed for PCB mounting....
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VOICE ACTUATED SWITCH 95¢ ea
COMPLETELY ASSEMBLED ON CIRCUIT BOARD AS SHOWN CONTAINS CRYSTAL MICROPHONE, GAIN CONTROL, TRANSISTOR AMPIFIER AND 4 AMP SCR, WHICH IS TURNED ON BY AUDIO FROM MICROPHONE.......REQUIRES 5-15 VDC FOR OPERATION......
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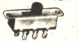

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DPDT snap action, high quality slide switch.. 1 5/8" mounting center
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20 PIN PACKAGE WITH PINS SPACED .1" IN TWO STAGGERED ROWS
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CD4025	CMOS 3 input NOR gate	DIP	.19
CD4011	CMOS 2 input NAND gate	"	.19
MC4015	TTL quad latch MOTOROLA	"	1.00
75451	dual peripheral driver	" (8)	.30
MM5058	1024 bit static shift reg.	"(8)	1.50
7402N	quad 2 input NOR TTL gate	"	.12
7430N	8 input NAND gate	"	.13
7492N	divide by 12 TTL counter	"	.30
SP380	(DM8836) NOR BUS receiver	"	1.00
DM8811	quad MOS interface IC	"	.50
8424	lo/pwr dual SR flip flop	"	.25
S270	pin compatible w/7400	"	.10
74178	(8270) 4 bit shift reg.	"	.30
LU321	dual JK flip flop SIG.	"	.25

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f706BPC	5W audio out w/heat sink	"	1.25
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LM308AH	micro/pwr op-amp	"	1.00
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Complementary	10 AMP TO-220 pwr. transistors, 2N6101 and GE D45H8 80/60V, 75/50W similar betas pair	1.25
MJE 1091	PWR Darlington TO220 60V, PNP, 70W Motorola	1.00
2N4304	N channel FET TO106 case	.25
40327	RCA NPN 300V, 1 AMP, 5W TO-5	.35
D41D1	G.E. PNP 30V, 1 AMP, 6W TO-220	.30

ONE AMP OP-AMP
HIGH POWER AMPLIFIER IN A TO-3 CASE REPLACEMENT FOR NATIONAL LH0021
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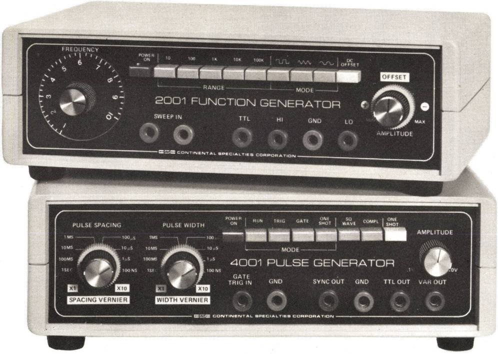

When it comes to signal sources, high precision and versatility don't have to mean high price. Proof? Our new function and pulse generators!

MODEL 2001 SWEEPABLE FUNCTION GENERATOR.

A wide-range 1 Hz-100 KHz source for stable, low-distortion sine waves; fast rise/fall-time square waves; high-linearity triangle waves . . . as well as a TTL square-wave output.

The 2001's voltage-controlled oscillator lets you remotely shift the generator's frequency by applying a DC voltage, or using an AC voltage to sweep its output over a 100:1 range. A pushbutton-selectable DC offset, allows you to shift output waveform centers above or below baseline at will. With its five overlapping ranges, high- and low-level outputs, Model 2001 is a remarkable value for professionals and hobbyists at $124.95.*

MODEL 4001 ADVANCED PULSE GENERATOR.

If we tried to list all the 4001's advantages, we'd run out of space before running out of features . . . so here are the highlights: Model 4001 is a precision digital pulse generator with fast rise and fall times covering 0.5 Hz — 5 MHz in 5 overlapping ranges. Pulse width and spacing are independently variable, 100 nsec — 1 sec.

Whatever type of testing you have in mind, the 4001 has a mode to match. Continuous. One-shot. Trigger. Gate. Even a compliment mode to instantly invert the generator's main outputs. And there's much more, including external triggering; square-wave, fixed TTL and variable outputs . . . to name but a few. The more digital work you do, the more you need our 4001. At $149.95*, it's very easy to afford.

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*Manufacturer's suggested list.

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New, K40 Magnamount: Grips like a grapple, actually improves transmission.

We double guarantee it.*

Exclusive Octopole Construction.

That's eight magnets set in eight different directions to give you a magnetic seal so complete and powerful, your antenna would stay up there if you could squeeze between two semis passing each other at 180 miles an hour. That's magnetic octopower.

*** GUARANTEE I**

Placed on the roof of a vehicle; properly tuned, the K40 Magnamount is guaranteed to transmit a further distance than a standard K40 without the Magnamount or you will receive a prompt and full refund from your K40 dealer who installed and tuned the Magnamount K40 for you.

*** GUARANTEE II**

Materials and workmanship are guaranteed for a full 12 months. Any part that fails to perform satisfactorily will be replaced absolutely free.

Exclusive K40 Flux Harmonics for Greater Transmission.

The magnetic radiation pattern was designed to match the K40 antenna radiation for greater distance than the standard K40. See our guarantee.

The facts: Physics and Physical.

1. Magnamount is a bigger, stronger magnet—in fact it's 8 bigger, stronger, magnets.
2. It doesn't just hold the K40 antenna, it helps it transmit further.
3. Remember the law of reciprocity. The antenna that transmits better, receives better.
4. It provides a flatter, lower SWR because the Magnamount is capacitance grounded.
5. It puts your 5/8 wave K40 antenna securely in place in the most advantageous place to work against a ground plane—high and free from obstruction. That's square in the middle, right up on top.

$15.95 buys it.
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K40 Magnamount.

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